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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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THE TELEPHONE COMPANIES.

THE mystery surrounding the nature of the union between the National and the New Telephone Companies has not been lessened by an "authoritative announcement" made by the *Standard* on the 2nd inst. It says, "Although provision has been made for the transfer of shares from one company to the other, the New and National Telephone Companies have not been, in the strict sense of the word, 'amalgamated,' nor have the prior obligations of the New Telephone Company been extinguished."

The relations of the two companies and the word which may be selected to indicate them, and whether that word be interpreted "in a strict sense" or otherwise, are matters of far less importance than the methods which may be selected for improving telephonic facilities. In a leading article the *Standard* says:—

"There can be no doubt that popular opinion is now thoroughly aroused to the imminent necessity for telephonic reform, and tolerably unanimous as to the means by which it is to be accomplished. The Central Cable Exchange on the twin wire principle has received the *imprimatur* of scientific, official, and public approval, and the demand for the introduction of this system will not be satisfied by a mere duplication of existing wires. The public have a right to expect that the companies will reorganise their undertakings on the lines indicated by the late Duke of Marlborough, as calculated to ensure the rapidity of connection through central exchanges, and the secrecy, as well as distinctness of communication, without which the British telephone problem is incapable of solution."

The attitude assumed by the *Standard* is sufficient to indicate an imminent danger to the telephonic service which may need all the strength of experience to prevent. The *Standard* accepts as assured all those claims to advantage which the late Duke of Marlborough and his associates urged, and gives its *imprimatur* as many others have given their *imprimatur*, in total ignorance that the system proposed, and the interchange of service proposed, are more likely to lead to what we have previously called "confusion worse confounded," than to any improvement.

Any *imprimatur* of approval of such a system must have been given by those who know even less about the subject than the Duke of Marlborough did. Our columns have shown that when the proposed system is examined in principle, its defence rests on assertions, and not on argument. The proposers of the system are adepts in the creation of a certain sort of public opinion, but the *Standard* should pause before assuming that on so technical a subject as telephonic service, any public *imprimatur* is of value. There is always a danger that that which may seem best for one is not best for all—an apparent paradox in most things but not in the case of telephonic service—in which that which is necessary is that which is best for all. A new

system in telephone exchange working should be received in a spirit of enquiry; an old system which has failed should not be revived without evidence that the causes of failure have been eliminated. The system proposed by the New Telephone Company is old; has been tried, and failed; and no evidence has been forthcoming that the causes of failure have been eliminated.

WHO REALLY INVENTED THE LIGHTNING ROD?

AN announcement has been made that the names of eminent electricians are to adorn the electrical buildings at the Columbian World's Fair at Chicago; but if historical precedence be a matter of any moment, one important name has been left out. We have it on the authority of Mr. Joseph J. Král that Procopius Diwisch, a Catholic priest and professor of philosophy at the Lyceum of Luka in the early part of the eighteenth century, was the man who, before Franklin, discovered the identity of lightning and electricity, and the issuing of electricity from metallic points—two important truths which led him to construct a lightning conductor.

The *Encyclopædia Britannica* knows nothing of Procopius Diwisch and the German Lexicon of Brockhaus (Vol. v., p. 406), disposes of his two great discoveries in exactly two sentences. The only mention of him that can be found in English literature is a short sketch in the *Historical Magazine* for February, 1868 (article xii., page 93), which is a translation from a French periodical. But Mr. Král has dived into the Bohemian *Encyclopædia* of Rieger and Maly, with the result that he has discovered a mass of presumably authentic data concerning the life and work of this remarkable man, who, while a fervent religionist, found time to become a scholarly scientist. These data are collected in Vol. i., pp. 209-210, and Vol. iii., p. 941, of the *Encyclopædia*.

We learn that Procopius Diwisch (Dyiv'ish) was born on August 1st, 1696, at Zamberk (Seuftenberg), in North-Eastern Bohemia. In 1720 he took holy orders, and shortly afterwards received the professorship of philosophy at Luka. He began to teach physics, with experimental demonstrations—a great innovation for those times. After a rather changeful career, in which at one time he was Prior of the Lukan convent (1741), he became a parish priest and settled down at Prendice to the study of electricity. His method of work was essentially experimental. Observations on thunderstorms soon led him to the discovery that lightning was but an electric spark. How thorough his studies were may be gathered from the fact that he worked out a complete theory of atmospheric electricity, a treatise on which was published from his papers after his death. This was entitled "Längst verlangte Theorie der meteorologischen Electricität, Tübingen, 1768."

Another important discovery followed soon after. Diwisch found out that "metallic points would both attract and discharge electricity more speedily than anything else," and he proceeded to make a practical application of the newly discovered truth. About the same time, Franklin, was receiving his first lessons in electricity from Dr. Spence.

Unusually prompt recognition of his services waited upon Diwisch. The Emperor Francis Stephen invited him to repeat his experiments before him and the Empress Maria Theresa, and rewarded him with two gold medals.

In 1753, Prof. Richman, of St. Petersburg, while observing a storm from a hut was killed by lightning descending an insulated iron bar specially erected for the purposes of the investigation. Upon learning of the fate of that martyr of science, Diwisch drew up a memoir on the incident and clearly showed how, in case of a storm, the danger of a lightning stroke could be averted by means of a conductor. This treatise he sent to the famous mathematician Euler, then President of the Berlin Academy of Science, asking for judgment. But the Academy failed to understand his reasoning. [N.B.—When Franklin's account of his discovery was read before the British Royal Society, it was laughed at!]

However, on June 15th, 1754, Diwisch erected the first lightning rod. The construction was as follows:—A pointed, slender iron bar formed the main portion of the conductor. Fastened to it were two cross-bars, thus making four arms, across each of which, in turn, a shorter bar was laid. Each of the twelve extremities thus produced carried a box filled with iron filings, in which 27 brass needles were stuck, making 324 needles in all. The main bar was supported by a wooden column sufficiently high (48 feet at first, afterward 132 feet) to secure protection for the building and its immediate surroundings. Several iron chains connected the main bar with the earth. The effect of this apparatus was soon demonstrated, thunderstorms being frequent at Prendice.

For two years Diwisch continued experimenting with his lightning rod, the results being published by Dr. Scrinci in the *Prague News* (1754). Having satisfied himself of its utility, Diwisch offered the Emperor a plan for erecting a number of conductors; this plan was submitted to the Viennese mathematicians, who reported so unfavourably upon it, that it was never carried out. Abbot Marci, in a letter to Diwisch about this time, refers to the unfavourable attitude of these mathematicians, and tersely puts the whole position in one phrase—"Blasphemant quae ignorant."

At last (1756) Diwisch was compelled to remove his lightning rod. There had been a very dry summer that year, which the farmers of Prendice ascribed to the erection of the rod there. It was consequently removed and deposited at Bruck, where it has been kept to this day. [N.B.—With this treatment compare the action of the Boston clergyman, who, in 1770, preached against lightning rods as "impious contrivances to prevent the execution of the wrath of heaven."]

Thus Diwisch was prevented from perfecting his lightning conductor, and from seeing its adoption in his native land. After this episode he turned to music, and invented a new instrument, which he named "Denis d'or," and which was a kind of organ. He died on December 25th, 1765.

Undoubtedly Diwisch knew nothing of Franklin, and there is no evidence that Franklin ever heard of Diwisch; their discoveries in electricity were wholly independent of each other. But Franklin found a people who understood him—the French; while Diwisch, by reason of his social position, was prevented from developing his idea. Again, Benjamin Franklin was a public man, who stood conspicuously before

three countries, while Procopius Diwisch was merely a parish priest of a small Bohemian village, with few connections.

An epitaph, written by one of Diwisch's contemporaries, wittily refers to the two inventions of this remarkable man :

Ne laudate Jovem, gentes ! quid vester Apollo ?
Iste magis deus est fulminis atque soni.

Which may be rendered—

Do not praise Jove, nations ! What is your Apollo ?
This man, rather, is a god of both the lightning and the sound.

Æsop up to Date.

A BULL which had possessed a field to itself for many years at last admitted a frog, very young in years as well as in sense, and the frog waxed fat and gross and was so overcome with the sense of its importance in sharing a field with a bull that it came to believe it was itself a bull, and expected to have as much deference shown to its miserable croaking as was shown to the bellowing of "my partner" the bull. One day, puffed with pride, the frog spat on farmer Dawson's boots, who, spying Mr. Frog the week following still squatting in the bull's hoof-prints and blown full of wind, gave it a squeeze under his broad sole and left it in a state of collapse, crying : "If you please farmer I did not spit on your boot." "I quite believe you my little friend," said he, "but I shall put my foot down just the same as if you had done so."

A Differential Wattmeter.

THE measurement of alternating power has occupied considerable attention in electrical circles for some time past, and the wattmeter method, at first discredited, has recently been taking its proper place again. Mr. Kennelly (working in the Edison Laboratory) has turned his attention to this subject, and has elaborated a form of instrument for the purpose of directly measuring the loss in a transformer at one observation. The idea involved has occurred to more than one person on this side the Atlantic, but Mr. Kennelly is first both to incept and to carry out the same. It is evident that if we fit two wattmeters to work on the same torsion system, and arrange to avoid all injurious mutual inductions, the restoring couple will measure the difference between the two powers measured in the circuits, provided the instrument be arranged differentially. This is what he has done, and the result is a very convenient and useful instrument for the purpose. Mr. Kennelly does not seem (judging from the description and cut given in his communication) to have sufficiently grasped the importance of avoiding any metallic parts, and of allowing for the capacity effect of the added resistance, which should be arranged so that the induction and capacity effects balance. A simple way of doing this (which we do not remember having seen described) is to make one part of the added circuit of a slit up sheet of tin-foil, and to have an opposing whole sheet ; if the distance between these sheets be alterable, it is easy to get the self-induction and capacity of the circuit, to have any required ratio within certain limits, and consequently to balance the one with the other.

High Frequency Currents.

MR. CAMPBELL SWINTON has recently made some highly interesting experiments bearing on the importance of frequency as affecting conduction. He has succeeded in lighting glow lamps by currents passed through the body when the frequency is very high. He explains this in the light of Lord Kelvin's calculations as to the skin conduction of alternating currents. With the frequency here employed, the current would only penetrate a very little way into the filament, and hence the resistance of the lamp would be very high. The current to produce the necessary power in the lamp need then be so minute that no inconvenience is experienced in passing it through the body. Prof. Elihu Thomson arrived at a similar conclusion with experiments of his own on glow lamps exposed to high frequency currents produced in his well known method. He has observed that such discharges may, however, prove fatal to animals, possibly by the body acting as a suitable condenser.

Ohm's Law.

The Philosophical Magazine in its last issue publishes a short communication from Mr. Sanford with regard to an alleged failure of Ohm's law. The author has been experimenting on the resistance of a copper wire when placed in various dielectrics, and has found a variation of considerable amount, especially when the dielectric is the vapour of sulphuric ether. In the form of apparatus used, the wire was of low resistance, and hence the bridge currents were fairly large, about 6 milliampères ; under such circumstances it is difficult to eliminate errors due to thermal effects, such as thermo-electric, E.M.F., and varying emissivity, so that, although the experiments are fairly concordant, further publication of the complete results must be awaited before any definite opinion can be formed as to the validity of the author's conclusion as to the dependence of resistance on the dielectric. Probably the effect is, as we believe, merely thermal.

Air as a Dissipator of Energy.

MR. TESLA has recently communicated a short article to the New York *Electrical Engineer*, drawing attention to the important part that air, or any other "discontinuous" medium in which the molecules are capable of rectilinear motion, may play, especially in the case of high tension high frequency currents. The fact that air can carry off charges by convection may lead in many cases to a large loss of energy, and Mr. Tesla considers that in such cases the air is fully as important a factor as the metallic resistance of the circuit.

Electric Waves in Wires.

IN some recent experiments by K. Birkeland on the measurement of the moving wave due to electric oscillations in copper wires the following conditions existed. Two wires, each 30 metres long, were arranged parallel to each other, the distance separating them being 80 centimetres. These wires were connected to square brass plates (40 cm. × 40 cm.) which were placed opposite to other brass plates of similar dimensions, the latter being in connection with the terminals of a powerful induction coil. By measuring the length of the spark passing between the terminals of a spark micrometer, Birkeland was enabled to estimate the potentials along the wire when the induction coil was in operation ; in making these estimations one of the knobs of the spark micrometer was connected to earth through a telephone, whilst the other was joined up to the wire by means of a sliding contact ; and to reduce the statical effects on the telephone to a negligible quantity the precaution was taken of laying a thread, which had been moistened with dilute sulphuric acid, across the wires near the collector plates. Measurements were made down to 0·0005 mm. *directly*, the passage of the sparks being immediately indicated by the telephone. In this connection we may note a recent account by Prof. Raoul Pictet of experiments made by MM. Sarasin and De la Rive, by which the rate of the electric waves have been measured. They used large metallic reflectors 16 m. in diameter, and allowed the discharge of the primary spark to take place under oil instead of in air, thus obtaining stationary electric waves, of which they were enabled to determine the nodal points.

A New Actinometer.

AN apparatus for the measurement of actinism has recently been described by H. Rigollet which presents some interesting features from an electrical point of view. It consists essentially of two plates of oxidised copper immersed in water containing $\frac{1}{1000}$th of either chloride, iodide, or bromide of sodium. One of the plates is exposed to the action of the rays of light, whilst the other is protected from this action either by surrounding it with parchment or paper, or by placing it directly behind the first plate at a distance of about a millimetre. The action of the light is instantaneous, and although the sensitiveness of the element decreases rapidly at first, it soon becomes virtually constant. The electromotive force of this apparatus is the phenomenon upon which the determinations depend; this varies with the colour of the light which acts upon it. A full account of this instrument occurs in the *Journal de Physique*, 1892. We note that Mons. Rigollet has investigated the electromotive force in different parts of the spectrum, and gives curves obtained by taking as abscissæ the lengths of the waves, and as ordinates the divisions read off on the galvanometer scale. He has investigated with this instrument the truth of Egoroff's conclusion, viz., that with iodised plates the intensity of the current is inversely proportional to the square of the distance from the source of light to the apparatus, and has demonstrated that this law holds approximately with Drummond's light as a source, that is to say, with a feeble light, but with sunlight the intensity increases more rapidly than the intensity of the current. The instrument is to be used in examining the luminosity of the sky in diffused light.

The Absorption of Electric Wave Energy.

ONE of the most important deductions from the well-known experimental work of Hertz, is that the production of resonance and the period of oscillation in resonators are not affected by the specific resistance or the magnetic properties of the secondary conductor. This conclusion is very suggestive, and amongst other scientists who have been led to follow up the subject recently, we notice that Prof. Bjernkes of the University of Christiania has been devoting some attention to it. The *Annalen der Physik und Chemie* (1892, No. 9., pp. 69—76) contains a paper in which the Professor details the chief results which he has so far obtained in his investigation. By means of an electrometer he estimated the absorptive powers, for the energy of electrical waves, of copper, brass, German silver, platinum, nickel and iron; all these metals were found to absorb the energy in different degrees. It was observed that the rate of absorption increased with the resistance and with the degree of magnetisation of the metal. In the cases of the metals, iron and nickel, a "damping" effect was recognised; their magnetisation, however, could be reversed one hundred million times per second. We, notice that Prof. Bjernkes makes no reference to the earlier papers of Professor John Trowbridge or of Professor Thomson on this subject; surely he cannot be unaware that they exist.

Radiant Energy.

STARTING with the far-reaching ideas of Faraday, Maxwell developed a theory of dielectrics in which, by the identification of light with electrical vibrations, he came to the conclusion that a ray of light must exert a certain pressure in the direction of its propagation, this pressure being numerically equal to the energy contained in each unit of its volume. Of this energy one-half is present in the electric, the other half in the electromagnetic form. By an entirely different line of argument, derived from an application of the second law of thermodynamics, Bartoli arrived at the same result. And the method by which he proved the existence of the pressure of light is free from objections, at any rate in the form given to it by Boltzmann in a more recent paper. But the process by which he calculated the numerical value of this pressure has recently been rather severely criticised by B. Galitzine. Bartoli does not *inter alia* appear to have considered the effect of rays of light having oblique incidence, and some of his methods of reasoning seem to be open to question. A translation of a paper by Galitzine appears in this month's *Phil. Mag.*, in which he deduces the formula for the pressure of light, giving three proofs. He attacks Bartoli's argument and whilst failing, as Maxwell did, to discover a relation between the pressure and the quantity of energy from purely mechanical considerations, he shows that the relation may be deduced from the principles of the electro-magnetic theory of light. Boltzmann showed this by a simple application of Maxwell's fundamental conceptions, but Galitzine gives a slightly different proof. The remainder of the paper is occupied with a mathematical discussion of the meaning of absolute temperature, of the second law of thermo-dynamics, and the relation between the radiating power and the surrounding medium. The paper is very rich in references to other writings, and, indeed, may almost be taken as a bibliography of the subject.

The Cause of the Magnetic Character of Minerals.

AN attempt at a solution of the question as to the cause of the magnetic character of certain minerals has recently been made by Professor Liversidge. He has examined upwards of fifty specimens, the method adopted in each case being the separation from the pulverised mass of the magnetic portion of the mineral by means of a rather feeble electro-magnet. From the results obtained, it appears that the magnetic properties of pyrrhotite unquestionably belong to the mass, but that these properties are due, in the case of chromite spinel, franklinite, garnet, limonite, and some forms of hæmatite, &c., to the presence of scattered particles of magnetite. To illustrate this we may quote from the Professor's results the facts that a dark compact hæmatite from Elba yielded 15 per cent. of magnetite; a specimen of New Jersey franklinite contained 32·23 per cent. of magnetic particles; samples of serpentines gave from a trace to 14 per cent., and chromite from New Caledonia, 0·7 per cent. of magnetite. Part of Professor Liversidge's investigation was concerned with the chemical aspect of the question, and he succeeded in showing that the iron sesquioxide obtained by precipitation from the acid carbonate of iron, or by heating the magnetic oxide, is magnetic, whilst he claims to have demonstrated that even ordinary iron rust, formed under atmospheric conditions by the oxidation of iron, is usually magnetic and polar.

Hall's Phenomenon.

THE so-called Hall effect, pure and simple, is a difficult thing to observe: its extreme smallness, for example, prevented Professors Carey Foster and Oliver Lodge, who sought for it amongst others, from discovering it. The explanation of the phenomenon has up to the present been somewhat unsatisfactory, and in discussing its relations, some have gone so far as to attempt to distinguish a real and a spurious Hall effect. Light has recently been thrown upon this obscure phenomenon by E. Lommel, who has succeeded in getting a visible representation of the equipotential lines in plates traversed by currents of electricity. From simple considerations he shows that the equipotential lines at right angles to the lines of flow in a plate are at the same time the magnetic lines of force belonging to the flow. A beautiful image of these equipotential lines may be obtained by strewing iron filings upon the surface of a plate when a sufficiently strong current is employed. If the plate be brought into a magnetic field, these magnetic lines of force alter their position, and therefore, also, the lines of force which are necessarily at right angles to them. And in this Lommel considers that there lies the simple explanation of Hall's phenomenon.

MUNICIPAL CONTRACTS.

By ALFRED H. GIBBINGS.

THE method of "tendering" for contract work, in all its varied forms, has been in use for such a number of years, that it may be almost regarded as a time-honoured custom.

At the present day it enters largely into the daily business of every manufacturing firm, and it is beyond question that this form of *obtaining* work on the one side, and of *paying* for it on the other, is, all things considered, the most satisfactory arrangement to both parties. Like many other good things, however, the system of tendering is liable to abuse, and in industries which are outside engineering circles, the grossest jobbery is every now and then discovered hidden under the formality of a tender.

The reasons why this does not often occur in the numerous branches of ordinary engineering, are principally that the requirements of the contractee are well defined in specifications, and in many cases the reputations of professional men are at stake. It is further to be observed on this point, first, that the common wide-spread knowledge of the requirements of engineering work has been built up out of a progressive experience, extending over a considerable period of the past; and second, that the experience thus gained would usually operate against the acceptance of low priced tenders, incompatible with the quality of the work tendered for. With respect, however, to electrical engineering—a thing of comparatively modern date—this experience has yet to be gained, and some time must necessarily elapse before it will ripen and consolidate. Consequently, it is very likely to be subject for a time to those evils in connection with contract tendering which arise in the early stages of every such new departure.

That such a condition of things exists to-day in the electrical world is apparent to everyone who reads the reports of those cases which come before the legal courts, and it is also borne out very largely by the immense number of popular electrical treatises which are now flooding the market. But it is not the writer's intention here to drift into a discussion as to the wisdom of accepting either the lowest or the highest tender for contracts of an electrical nature, nor must it be assumed that the evils in contract tendering referred to above, are in any way analogous to jobbery. As a preliminary to our remarks on "Municipal Contracts," we think it may be stated, that whilst the public generally are aware of a few salient facts and features of electricity as an illuminant, and are not ignorant that many different systems exist, each varnished by their respective advocates, yet that they are altogether incompetent as yet to discriminate effectively between their merits and demerits, and so, of course, are quite unable to make any wise selection.

This is the case *most* especially with municipal authorities, and the lack of self-confidence, not to say trepidation, with which they enter upon electrical undertakings, is exemplified by the large variety of methods which they adopt for obtaining the information they require. Some interest themselves so far as to form a special committee with the object of visiting successful installations; others whose members may not be so energetically inclined, call in the aid of their own engineer and draw up their own specification; and others again there are who would be content to leave the whole matter in the hands of an electrical expert, who may, or may not be, interested in one particular system.

Each of these methods leaves a great deal to be desired, and therefore they all have the disadvantage which attaches to imperfection. What would be thought, for example, of a body of commissioners, who after inspecting a dozen different systems of drainage, chose one for a certain prominent and attractive feature without considering at the same time its general adaptability to the town? Such a course of procedure carries its own condemnation with it, but electrical engineers who have had a wide experience in carrying out corporation installations, know well that the fundamental points such as the facilities which a district affords to the laying of the mains of any chosen system, and the utility of that system as regards private consumption are just the very matters which, in the vast majority of cases, are left to take care of themselves.

There is but one way of reforming such a state of affairs as this, and that is by reforming it altogether. Let municipal authorities cease to believe in the feasibility of dealing with electrical undertakings in piecemeal fashion, and, above all, let them have a wholesome distrust of their own competency, as individuals, to decide the most important matters in connection with those undertakings. Let them lift it above the level of a mere mechanic's job. Let them obtain the services *from the first* of a competent electrical engineer experienced in the principal methods of electrical distribution, able to draw up the details of a contract, and to superintend the carrying out of the whole work from its initiation to its close. He should be able in his own sphere to undertake similar duties to those of the town surveyor, and with the assistance of that official should be entrusted to exercise his knowledge and experience in placing the different portions of the work in the hands of the most reliable firms. The adoption of this course of action does not necessarily imply that the advice of a bonâ-fide consulting engineer must be dispensed with altogether, any more than it prevents the work being openly tendered for. On the contrary, the practical knowledge of the superintendent electrician should be of the greatest help to the consulting engineer in drawing up the specification, and it is only just that the superintendent should be accorded this privilege.

Although in one or two instances this policy has already been adopted with marked success, yet it is almost too much to hope that it will become universally approved for some years to come. But it is very easy to understand the secret of its success. Those electrical engineers who are filling the appointments and are carrying out the whole of the duties in connection therewith, and on whom are entailed all the responsibilities of their decisions, have a reputation to make or lose, and consequently put the whole of their energies into the work.

The mistake which is too frequently made by municipal authorities is to swallow wholesale the one-sided advice of an interested consulting engineer, and *afterwards* to appoint an electrical engineer to superintend a system which he may know from experience to be disastrously defective. How often, for instance, do we see advertisements substantially like the following? "The Corporation of Muddlewick invite Tenders for the laying down of the necessary plant and mains for the supply of electricity in the borough, &c." Then after the lapse of a month or two, when presumably a tender has been accepted, another advertisement appears for an "Electrical Engineer to superintend the construction of mains, and capable of managing a Central Station, &c."

The applicants are rightly required to possess exceptional testimonials, capabilities and experience, of the benefit of which, however, the corporation clearly deprive themselves. Their practical knowledge of merits and demerits in the various systems is, of course, largely available, after a contract has been drawn up and signed, and in fact it often happens in such cases that they are simply called in to make the best of a contract with the most important clauses omitted.

That this is totally unfair to the electrician there can be no question, but after all the greatest disadvantage is to the public.

There are two methods sometimes adopted by municipal authorities which deserve mention, and which do not come immediately within the scope of the foregoing remarks. One method is to make a transfer of the electric lighting powers to a company formed with this object, and which is generally comprised of shareholders in a firm of electric lighting contractors. Such an arrangement is beyond further comment here. The other method is to advertise for schemes, merely setting forth the probable requirements in the abstract. It is not surprising, therefore, that the schemes submitted by the various firms anxious to obtain the contract, are not in any two cases alike, nor are they formulated on any basis on which a fair comparison can be made of their respective merits. In a case which recently came under the notice of the writer, the utmost care and patience were required to reduce the various suggestions to a common ground for consideration. One firm sent in the portion of their estimate for lighting, calculated and enumerated for 8 C.P. lamps; another firm adopted 16 C.P. lamps only, while the majority were mixed up with arc lights, and 8, 16, 32, and 50 C.P. lamps, relegated to various positions, entailing a hopeless tax on the tender examiner's judgment.

The inevitable consequence of all this is simply to produce

bewilderment in the minds of a body of commissioners, and ultimately the whole matter is left to the decision of an electrical expert. This is not, however, very common, and occurs more frequently in connection with schemes for the electrical lighting of the municipal offices.

Are we to assume that the reason of such unbusinesslike ways is that municipal commissioners are mostly a body of unpractical men, and therefore entirely in the hands of the officers they employ? Or is it because the position of electrical engineer to a county borough or a local board, instead of being of similar and co-ordinate rank with the corporation engineer and surveyor, is subordinate to it?

Whatever may be the actual reason for such erratic courses, it is high time that some rational method should be adopted, in the interest of all parties, so that the contract selected and approved should be the one best suited to the requirements of the district, and last, but not least, so that the superintendent of the work to be carried out should have some voice in the drawing up of the final specification.

THE RELATIVE COST OF ELECTRIC LIGHT AND GAS.

IT is always interesting to hear of comparisons of gas and electric light from actual practice, and in *Electrical Industries* for December, 1892, there appeared a short article on this subject by Mr. W. S. Southworth. The main data are as follows:—

Building.—The Massachusetts Cotton Mills.

Dynamo.—Edison machine: 600 20-C.P. lamp capacity, = presumably, 48,000 watts.

Conditions of Running.—Dynamo runs whenever the mill machinery runs. Position of mill is such that light is much obstructed by close proximity of adjoining buildings. A considerable number of lamps are required even in the height of summer.

Number of Lamps Installed.—510 20-C.P. Edison.

Voltage.—The lamps are ordered one or two volts higher than that of the dynamos. (This will account for the abnormal life of the lamps.)

Average Lamp Hours per Annum.—431,220. (This was actually measured during one year, and is taken to hold for the remaining four. Electric light has been used instead of gas for five years.)

Average Renewals.—276 lamps per annum.

Average Life per Lamp.—1,319 hours. This is arrived at thus: Add 10 per cent. of existing lamps to number of renewals, and divide 431,220 by the figure thus obtained.

Power used.—Water (apparently, though it would appear from the article that other power was available).

In the absence of any means of checking the above figures we must assume them as correct. But Mr. Southworth's comparison of the relative cost is open to criticism. He writes:—"The largest item is, of course, for power. I estimate the average requirement at 20 horse-power, which I put at \$25 (£5) per horse-power per annum. . . . . For depreciation and repairs I allow \$250 (£50); interest \$225 (£45); lamps \$110 (£22); oil and attendance \$75 (£15)."

This adds up to \$1,160 a year (£232). The gas bill was formerly \$1,500, or £300 per annum, which would show an economy of $\frac{300-232}{300}$, or nearly 23 per cent. But apart from this there must be a greatly increased lighting efficiency due to the electric light, as the following figures will show:—

The average candle-power-hours amount to $431{,}220 \times 20 = 8{,}624{,}400$ per annum. Allowing $2\frac{1}{2}$ candles per foot of gas, this would represent a yearly consumption, light for light, of $\frac{8{,}624{,}400}{2{,}500} = 3{,}449{\cdot}76$ thousand cubic feet of gas, which at \$1·10 per thousand (the price given) would amount to \$3,794·73. But the gas bill formerly was \$1,500, hence there should be $\frac{3{,}794}{1{,}550} = 2\frac{1}{2}$ times as much light now as formerly.

It is probable though, that owing to the manner in which the lamps are used, and to the voltage of the lamps, that each 20 C.P. lamp gives in practice not more than 14 C.P. throughout the year. Even on this assumption there must be $2{\cdot}5 \times \frac{14}{20}$ or 1·7 times as much light as formerly.

The total cost per unit, allowing $4\frac{1}{2}$ watts per candle as actually required by the lamps under existing conditions, is

$$\frac{\$1{,}160}{14 \times 4\frac{1}{2} \times 431{\cdot}220} = \$0{\cdot}0428,$$

or roughly $2\frac{1}{4}$d. per unit. This is not a very great economy having regard to the fact that the dynamo appears to be driven by the same machinery as the mill.

But Mr. Southworth's figures are not very precise. The allowance for interest and depreciation appears reasonable. £22 for 276 lamps shows that lamps must be cheaper in Massachusetts than over here or on the continent. Oil and attendance £13 per annum is certainly a very low figure.

It is a pity that so few opportunities are afforded for a comparison on a practical basis of the relative cost of electricity and gas considered from every point of view.

ROTATION OF THE MAGNETIC FIELD.

IN our issue of January 27th we reproduced from the New York *Electrical Engineer* an article, by Mr. Charles Steinmetz, on the above subject. The following letter has now appeared in our contemporary's columns from the pen of Mr. Townsend Wolcott. Our contemporary heads the letter "Is Steinmetz or Faraday right?"

"In your issue of January 11th I notice an article on the 'Rotation of the Magnetic Field,' by Mr. Charles Steinmetz. This article is evidently intended as an answer to my criticism (p. 391, Vol. xiv.) of his article (p. 310 Vol. xiv.) on 'Twisting Magnetism.' Mr. Steinmetz might have stated this fact without any fear of offending me, but as he did not, I have here done it for him.

"Mr. Steinmetz states that 'as long as the two characteristic quantities of the magnetic field, the intensity and the direction of the magnetic force, are constant in any point of space, the magnetic field must be said to be stationary and constant at this point of space.' It is scarcely accurate to speak of direction as a quantity, but as the meaning of the sentence is clear, and as I do not wish to be hypercritical, I will let that pass.

"I scarcely think that Mr. Steinmetz meant what he wrote, as the words quoted are equivalent to saying that a uniform field of force must be fixed in space. For instance, assume a tangent galvanometer producing a magnetic field of sensible uniformity over a considerable space. Now suppose a small ring hung with its plane normal to the lines of force, from some fixed support outside the galvanometer. Next move the galvanometer in the plane of the ring, but not enough to bring the ring outside the uniform field. As the ring still encloses the same number of lines of force, there has, of course, been no current or even E.M.F. induced in the ring.

"According to Mr. Steinmetz, the field of the galvanometer has not been moved; according to everyone else it has. But disregarding, as he does, what everyone else says, I think that even Mr. Steinmetz will admit that when he carries a permanent magnet around in his pocket he also carries the field with it, whether the latter is uniform or not. If he does not, he utterly deprives the term 'field of force' of any intelligible meaning whatever. As the earth rotates upon its axis, the imaginary lines called meridians, rotate with it. We do not find the meridian of Greenwich, for instance, later in the day passing through New York and so on by the way of San Francisco and the Pacific Ocean back to Greenwich.

"In the same sense in which the geographical meridians rotate with the earth, so do the magnetic meridians (neglecting the small diurnal variation); and so do the lines of force of every magnet, if the term 'magnetic line of force' has as much meaning as the term 'mathematical line.'"

THE LIVERPOOL OVERHEAD RAILWAY.

THERE has been much said and written about this enterprise, and deservedly so, for the Liverpool Overhead Railway is the latest development, and one of the greatest achievements of these modern times. Not only have Englishmen watched the progress of this work with interest, but Americans have followed the enterprise with the keenest appreciation. The successful initiation of this railway, in fact, appeals with greater force to our cousins across the water, and while we may congratulate ourselves upon striking out in a new direction, there can be little doubt that Americans will profit more than we from this new railway. In electric railways pure and simple, we are taking up a strong position, and when the electric railway schemes for London are realised, we may fairly claim that the spirit of advancement has settled upon us.

THE HISTORY OF THE SCHEME.

It is a little curious that while the home of elevated railways is undoubtedly in America, the original conception of such a system of traffic undoubtedly belongs to a Liverpool engineer. In 1852, Mr. John Grantham proposed a high level railway to run from Mersey Forge to the land opposite Huskisson Dock, a distance of about four miles. The scheme was laid before the Dock Board, and though it received the strong support of Liverpool merchants, the Board refused seriously to entertain the matter. In spite of the unceasing arguments of Mr. Grantham, he never prevailed upon the board to consider the scheme, and it was at length abandoned.

It was not long, however, before the increasing traffic alongside the docks rendered an improved form of transit necessary, and in 1877 the engineer to the Dock Board was authorised to prepare plans for a single line overhead railway. Estimates were provided which showed that the cost of such a railway would amount to £146,000. A Bill was obtained from Parliament, but the Board of Trade would not consent to the erection of a single line, and again the matter seemed to hang fire. In 1881 fresh powers were obtained for the erection of a double line of railway, but nothing was done until 1886, when the Dock Board leased their powers to an independent company. This company was formed with a strong directorate, amongst which were Sir Wm. B. Forwood, Mr. Harold Brocklebank, and other strong local men. The prospectus was issued on March 25th, 1889, and closed on the following day, more than double the required capital of £450,000 being subscribed. As will be seen later, the length of the line is a little more than six miles, but the shareholders, a few days ago, sanctioned an increase of capital, which would permit of an additional three miles being added.

The building of the structure has entailed many an interesting piece of work, the details of which, however, are scarcely within the scope of an electrical paper. In one or two cases, where the railway crosses entrances to the docks, tilting bridges have been erected, which practically tip some yards of the structure into the air. Where the line crosses the Stanley Dock a swing bridge has been built; the mode of erection of this was ingenious. The contractor had to remove an old bridge, and throw across the cantilever of the railway bridge in a remarkably short time; yet this, along with many another difficulty, was successfully overcome, and the railway is another monument to the ability of English engineers.

THE STRUCTURE.

The railway is composed almost entirely of wrought iron and traverses the whole length of the famous Liverpool docks, a distance of about six miles. The extensions, north and south, authorised last session, go beyond the docks and away from the river, in order to give better access between the residential neighbourhoods reached by them, the docks, and the heart of the city.

With the exception of a short length where the line passes under the Lancashire and Yorkshire Railway coal sidings, the railway is, as its name indicates, overhead, and for the most part just over the lines of the original Dock Railway, which is upon the surface. The latter railway serves for the distribution of goods by horse traction, and has been used also by passenger omnibuses, with specially constructed wheels to enable them to leave the track when necessary. They will leave the rails altogether upon the completion of the Overhead Railway, which will afford a means of transit at least three times as rapid. The Dock Railway will then be available exclusively for goods.

The Overhead Railway consists generally of plate iron girders, supported upon channel iron columns, and carrying an iron flooring, upon which the permanent way is laid direct, without the usual intervening ballast. The normal spans are 50 feet, but there are some of 100 feet, with bowstring girders, and others of special construction for opening and affording a passage to the docks for exceptionally bulky goods, such as marine boilers, &c.; thus there is a tilting bridge near the Sandown Dock, and a swing bridge of novel construction, and worked hydraulically, crossing the entrance to the Stanley Dock. This is the only dock entrance crossed by the railway, the other docks being on the river side of it.

The columns are grouted into cast-iron sockets, bedded in and bolted to masses of concrete, forming the foundations.

With the exception of some half-dozen spans, the line has been constructed without the use of scaffolding, and with very little interference with the traffic, either of the docks or of the streets.

This important end was attained by adopting a construction which admitted of each span and its flooring being put together at one end, and transported as a whole over the already completed portion of the railway.

A depôt was established at the north end of the railway, where the flooring was constructed and riveted together, and to the main girders. The whole span was then raised by jacks; a steam trolley with wheels running upon the two rails nearest the main girders (and thus having a gauge of 16 feet), was run under the span, which, being lowered upon the trolley, was carried by it at such a level as to clear the main girders to the southern end of the structure. Arrived at this point, the span was slung upon a movable gantry, and by it deposited upon the columns prepared to receive it. In this manner span after span was added, as many as 12 being placed in a week, representing a length of 600 feet of railway.

The permanent way is of a novel construction. Longitudinal sleepers, resting directly upon and keyed to the arched decking, support the rails and the electric conductor.

The decking is of arched plates, finishing to 2 feet 6 inches wide and 15 inches deep, made water-tight by asphalte placed in the V-channel between the arches; this form of flooring (known as Hobson's arch plate system), first used on this railway, is being extensively used elsewhere. It is, for its weight, of great strength and stiffness, and is readily made water-tight.

The flooring is made of ordinary iron plates and tees. The plates are 46 inches wide by $\frac{5}{16}$ inch thick, and vary in length from 22 to 27 feet. The tees are $4\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}$ inches section, and are of lengths corresponding to the plates.

In order to ascertain the exact strength of the floor, some actual sections were tested to destruction, and the deflections at each increase of load were carefully tabulated with the following results :—

Test.—*a*. Three sections of floor measuring 7 feet 6 inches in width.

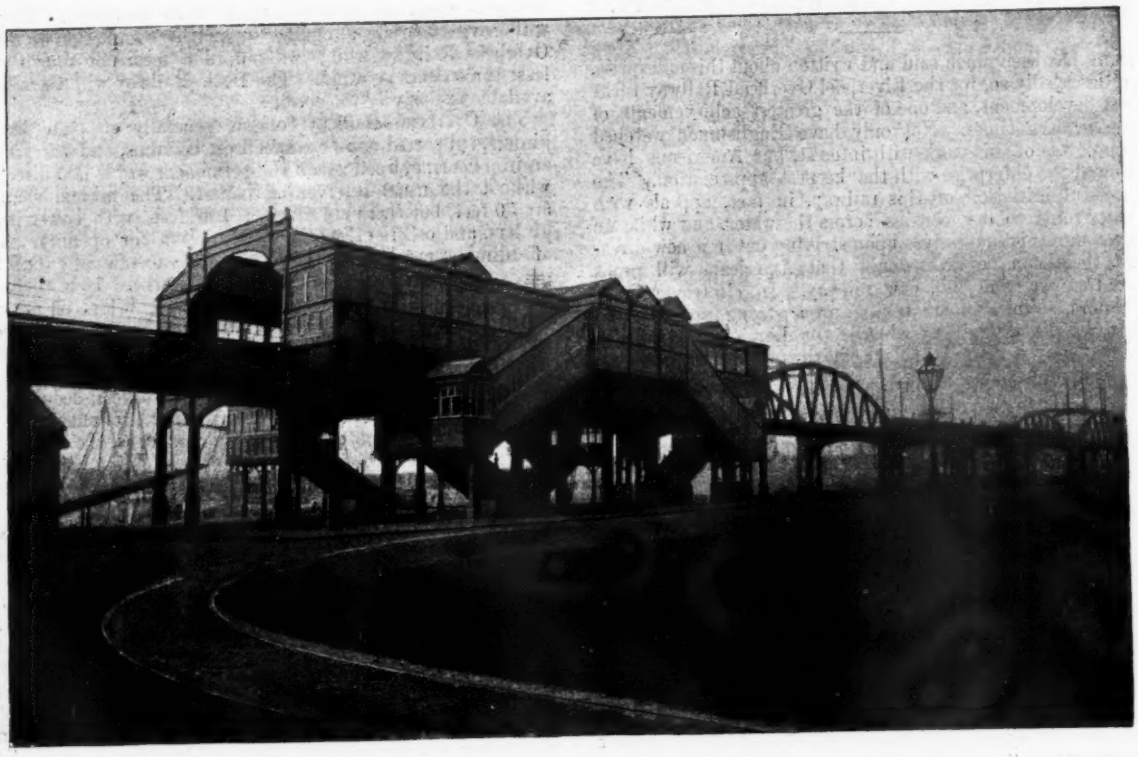
b. Span, 22 feet, ends resting upon supports.

c. Load distributed over four points corresponding with the positions of the rails.

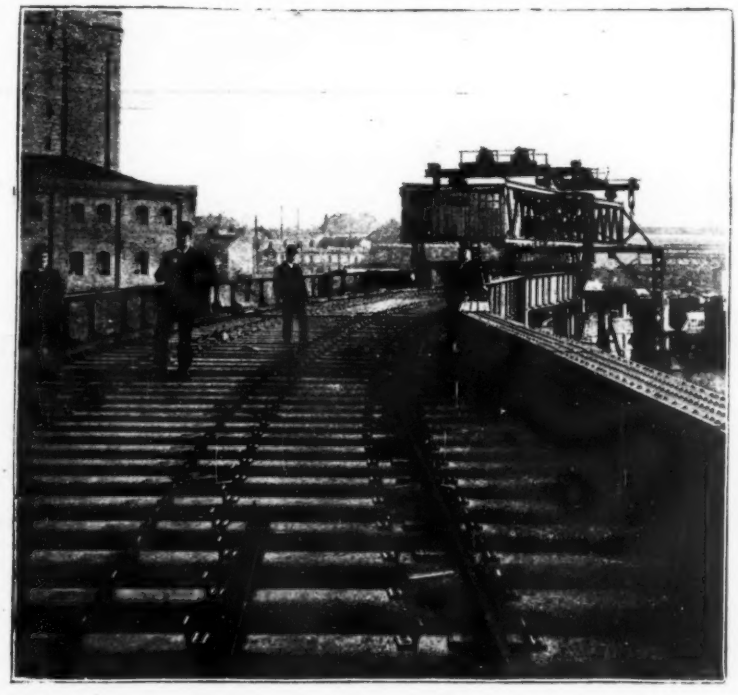
Test load.	Deflection at centre.
30 tons	nil
35 „	$\frac{1}{4}$ inch.
40 „	$\frac{7}{16}$ „
50 „	$\frac{9}{16}$ „
60 „	$\frac{3}{4}$ „
70 „	$\frac{15}{16}$ „
80 „	$1\frac{1}{8}$ „
90 „	$1\frac{1}{2}$ „
100 „	$1\frac{9}{16}$ „
110 „	2 „ (limit)

The floor plates ultimately collapsed by the total rupture of the T-irons at 163 tons, and with a deflection of 10 inches.

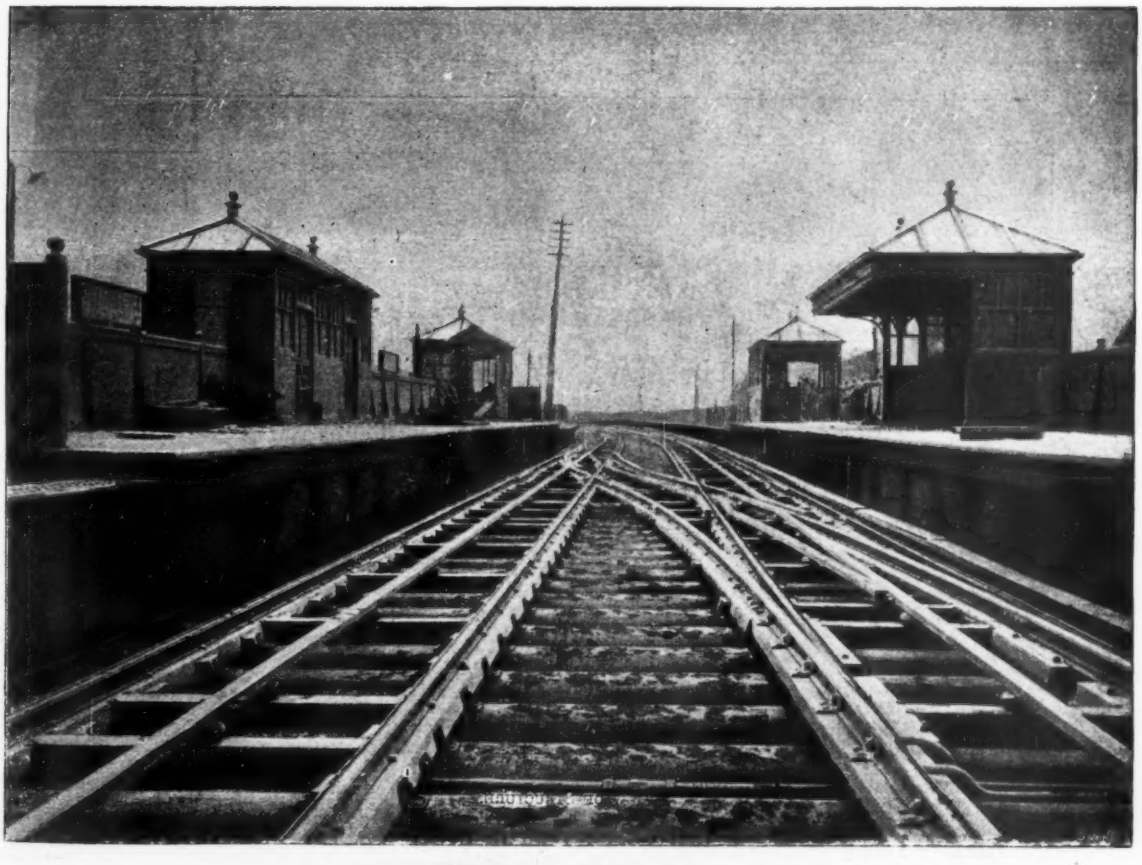
The construction of the decking is somewhat as follows :—The flat plates are delivered sheared to exact length and width. Six of them at a time are heated in a long oven (to a cherry-red heat), whence they are separately hauled out



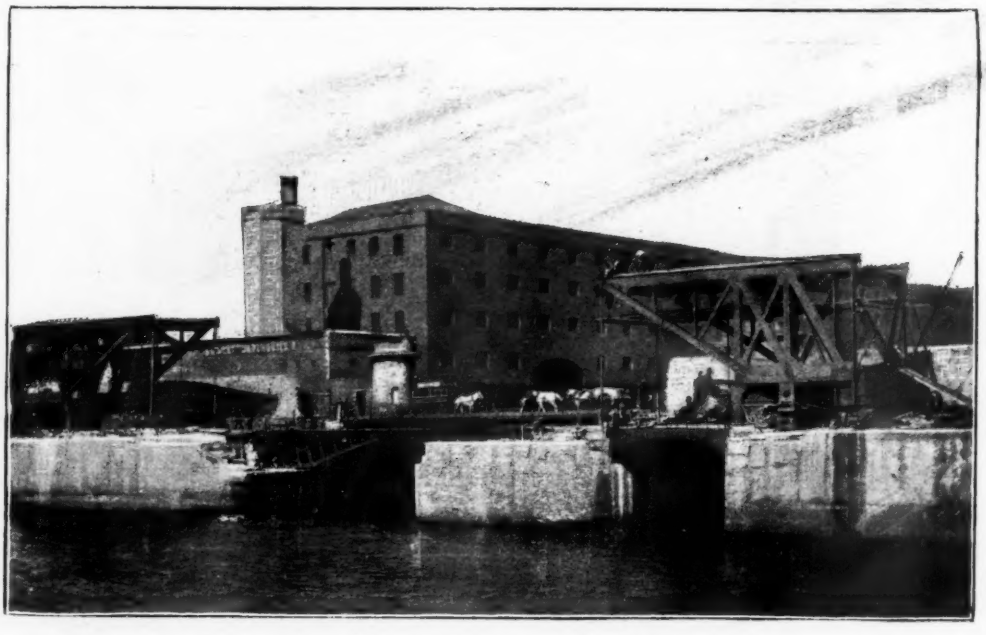
VIEWS OF STATION.



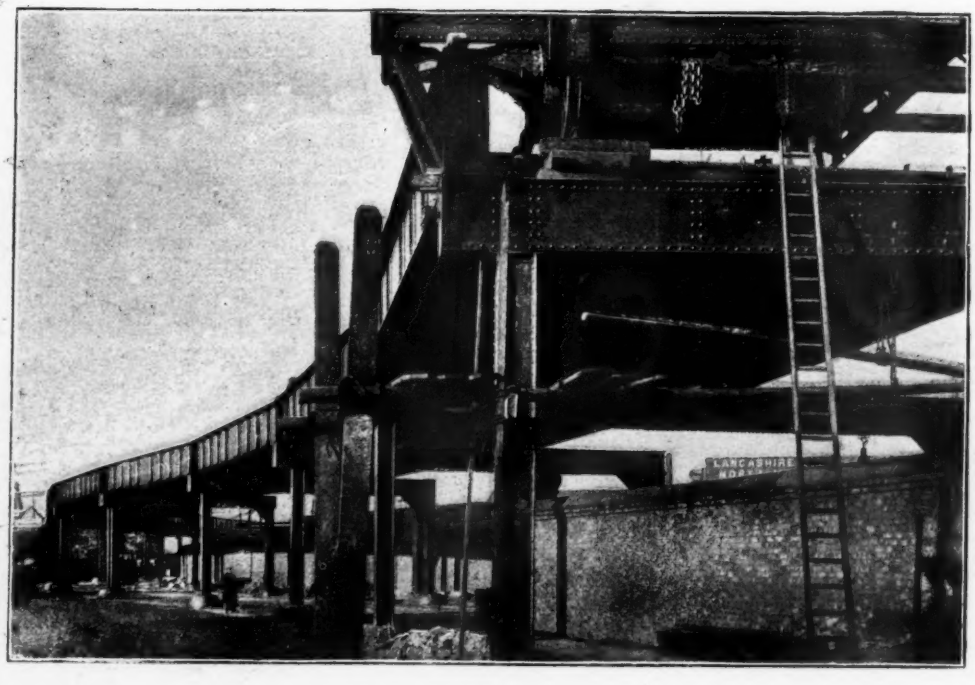
Line in Course of Construction.



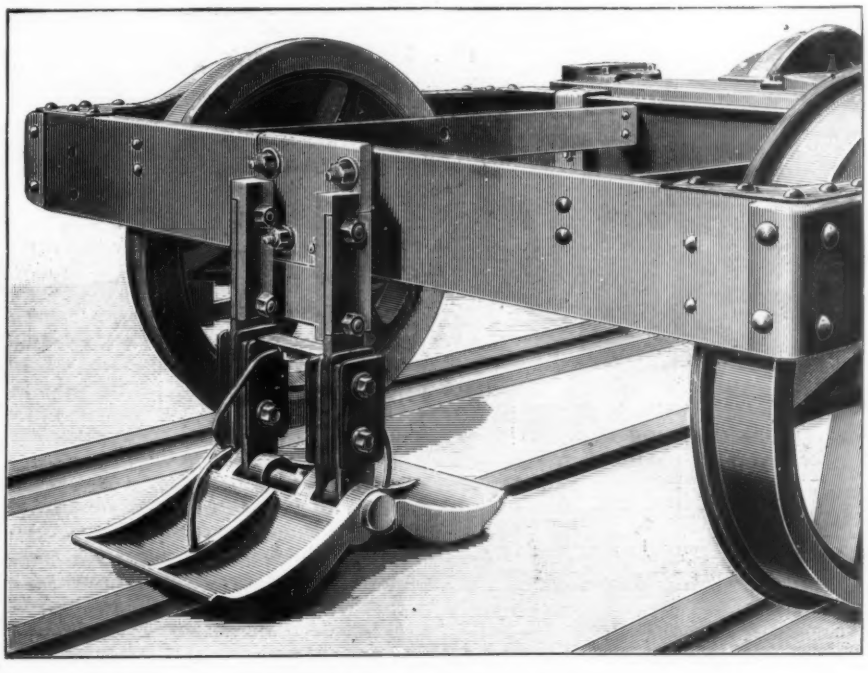
Cross-over Junction.



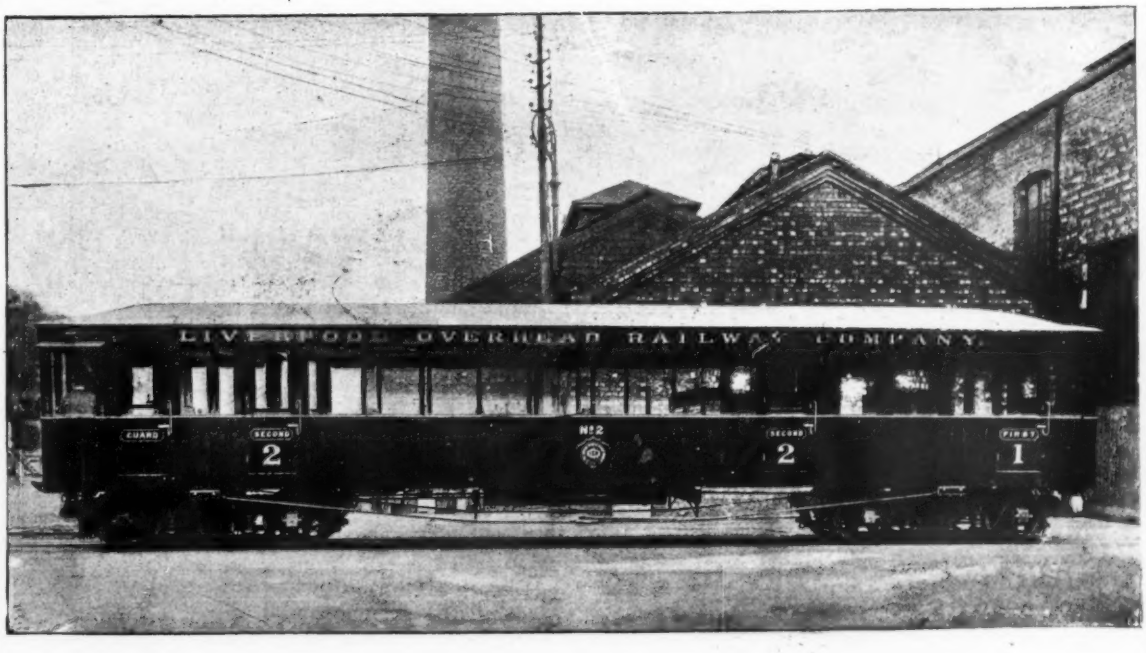
ERECTING SWING BRIDGE OVER STANLEY DOCK.



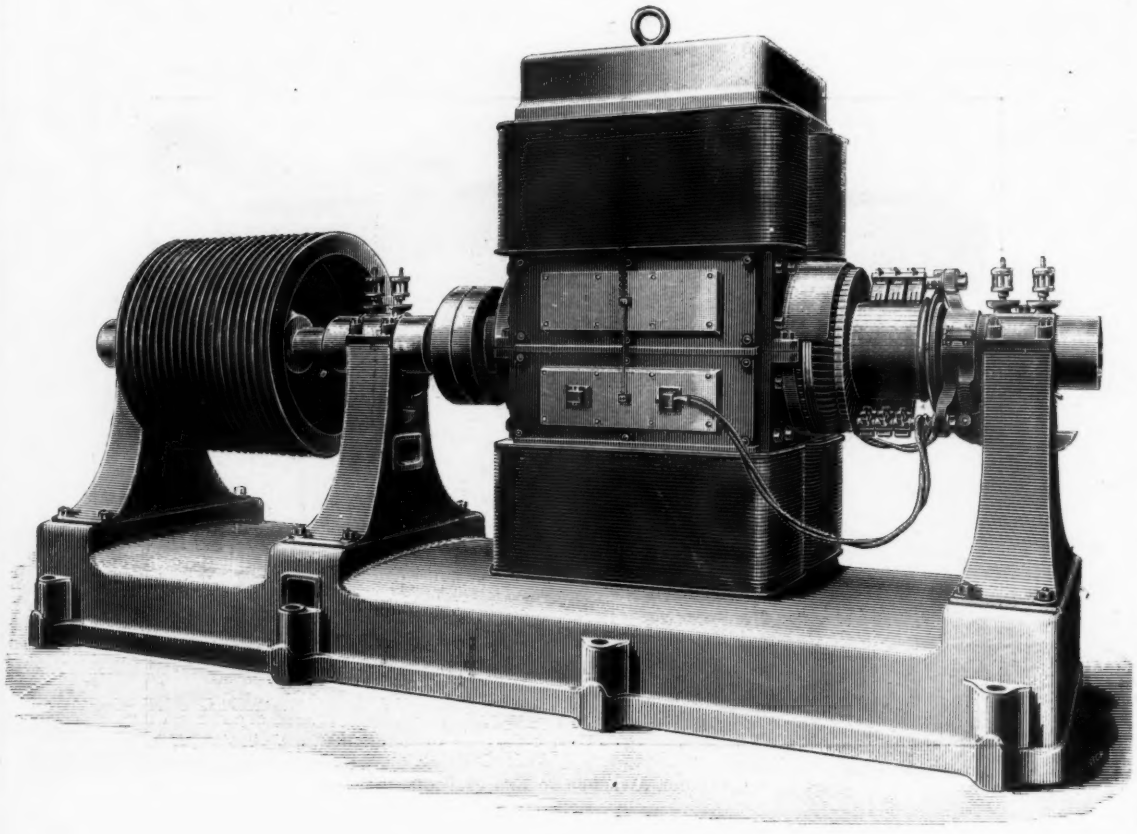
VIEW OF STRUCTURE.



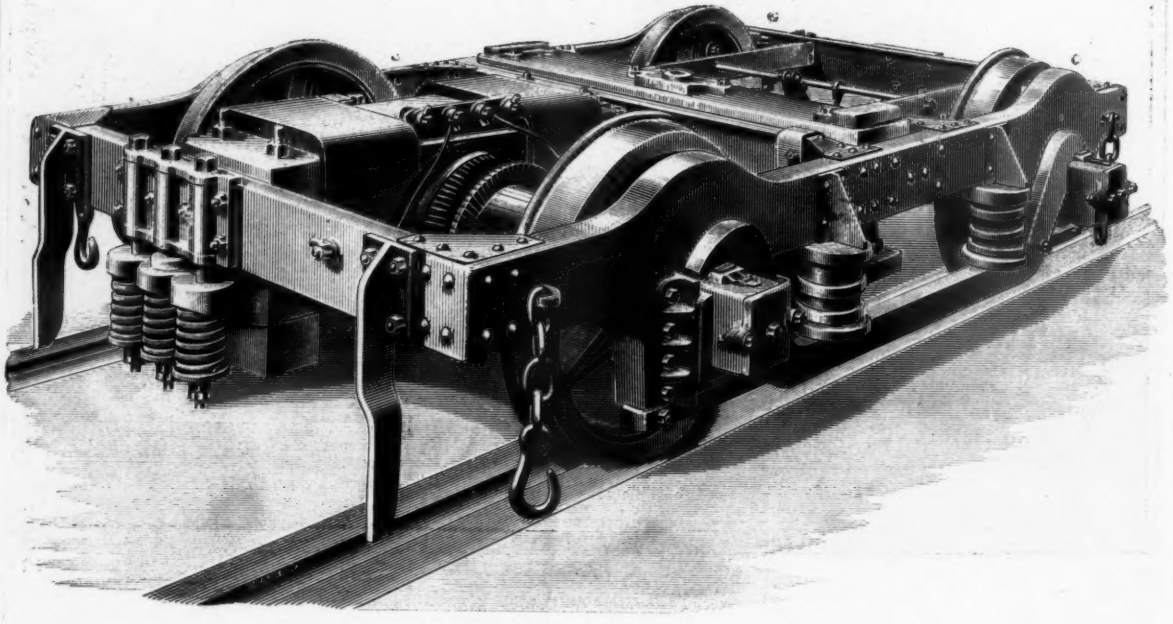
COLLECTOR ATTACHED TO END OF BOGIE.



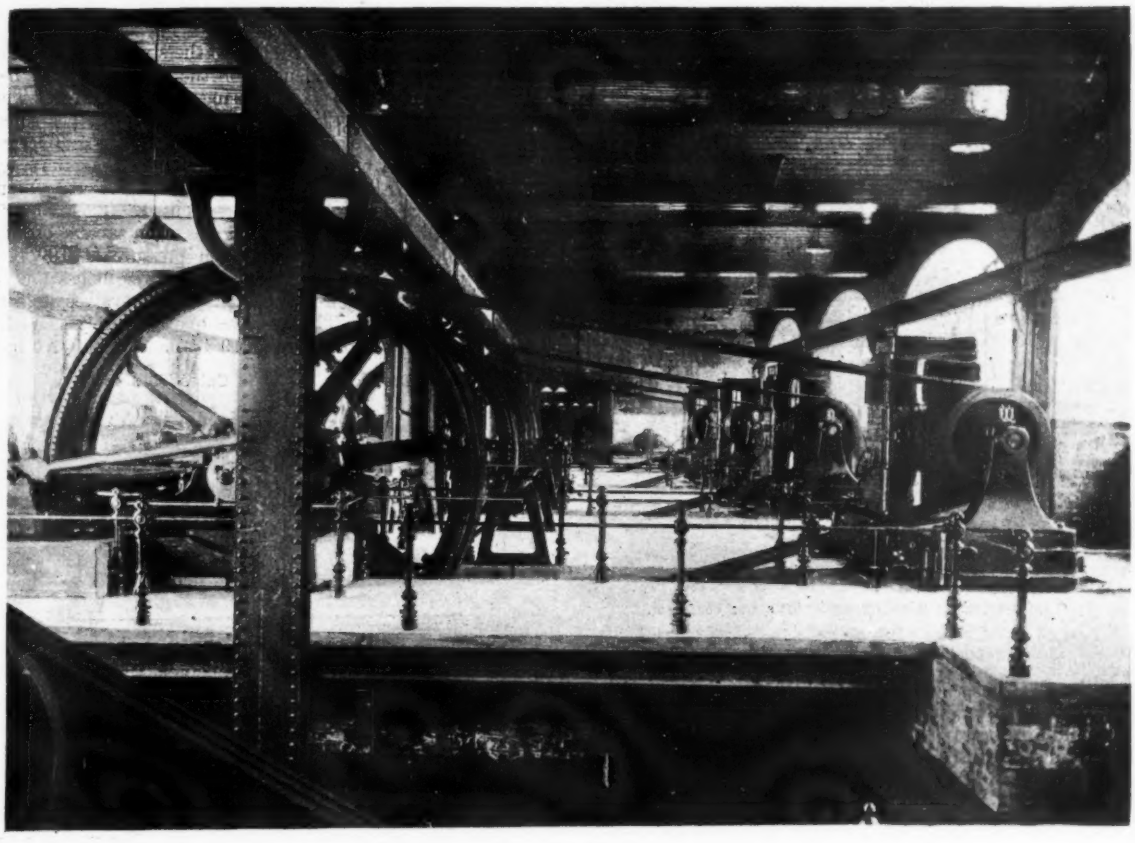
VIEW OF CAR.



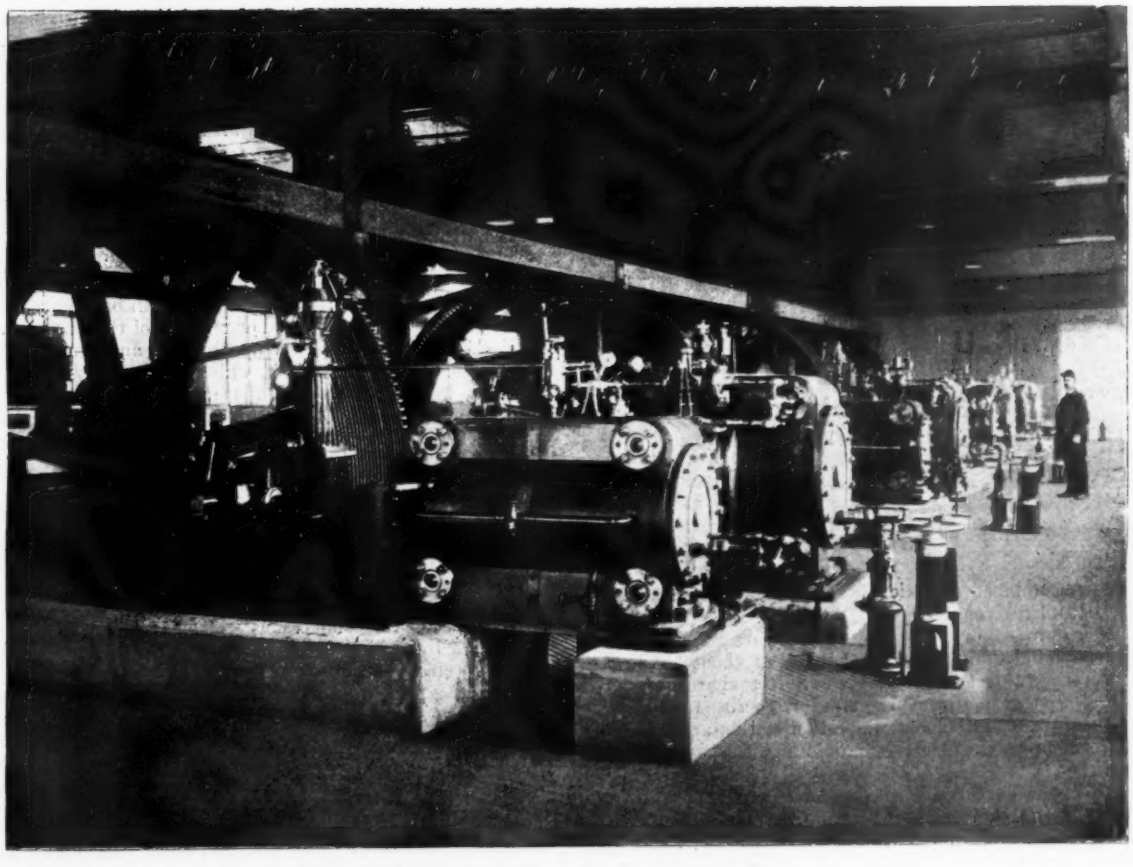
Elwell-Parker Four Pole Dynamo.



Bogie with Motor Attached.

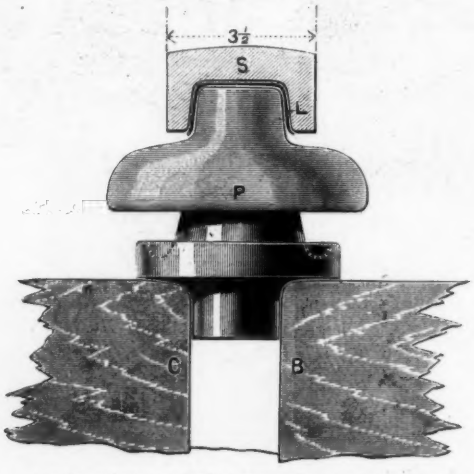


A VIEW OF DYNAMOS IN GENERATING STATION.



VIEW OF ENGINES IN GENERATING STATION.

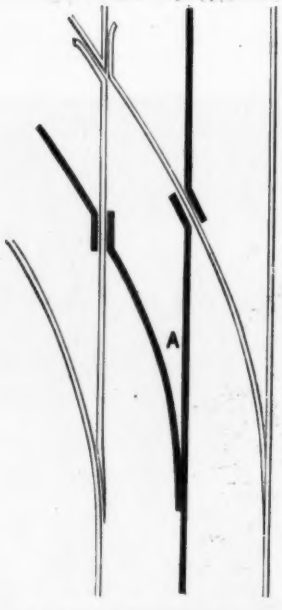
endways into a hydraulic press, which bends them to the required shape. After cooling upon a grid or frame, where they are tightly held to prevent change of form, they are taken to a multiple drilling machine, which drills the



C, B, Cross timber; L, lead; P, porcelain; S, steel conductor.

INSULATOR.

requisite rivet-holes (about 200) in two operations and in 15 minutes. After the end angle irons, for attachment to the main girders, are added, the decking is completed by riveting mechanically the curved plates to the T-irons forming the lower member.



ARRANGEMENT OF CONDUCTOR AT CROSS-OVER ROADS.

These combined operations were performed at the rate of 40 to 45 plates per day.

There are to be 15 stations. They are built upon iron girders and columns, the platforms being about 115 feet in length by 12 feet wide, and are 3 feet above rail level. Access to the platforms is gained from the street level by four staircases at the more important stations, and on each platform a waiting shed is provided with pay-offices and turnstiles.

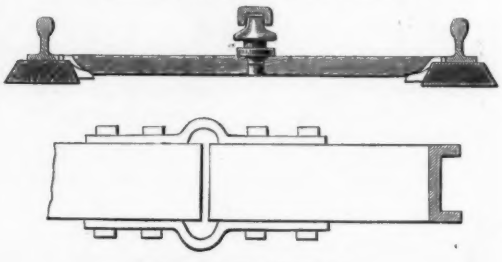
An extensive carriage shed is erected near the Hornby Docks, with five lines of way running through at the same rail level as the main structure of the railway; and underneath, on the ground floor, is the repairing shop, to be equipped with the necessary tools.

THE GENERATING STATION.

Steam Plant.

The generating station is close to the structure, and about the middle of the whole length of the line. Installed here are six Lancashire boilers, measuring 30 feet by 8 feet. They are designed for a working pressure of 120 lbs. per square inch, and are fired by Vicars mechanical stokers. The coal supply is drawn from hoppers overhead, into which the trucks on the adjoining coal railway are emptied. A Green's fuel economiser, consisting of 384 pipes, is used. There are four horizontal coupled compound engines, each capable of indicating 400 H.P. with 120 lbs. steam pressure at 100 revolutions per minute; the cylinders are 15½ inches and 31 inches diameter and 36-inch stroke. Corliss valves are fitted to all the cylinders. The fly-wheel of each engine is 14 feet in diameter, and is grooved for 19 1¼-inch ropes. An inde-

INSULATOR FIXED IN CROSS TIMBER.



BONDING OF CONDUCTOR.

pendent condensing arrangement is used, divided into two units, each of which is capable of condensing steam for three of the main engines when running under full load. The condensing water is taken from the dock adjoining the generating station.

Air and circulating pumps are driven by small compound vertical engines, which are fitted with Ferguson's patent triangular connecting rods. The cylinders are 7½ inches by 15 inches diameter. The auxiliary plant consists of two pumping engines for boiler feeding, each capable of supplying four boilers; one engine of 10 I.H.P. for driving the stokers and conveyer, and two small engines for working the scraper on the economiser. The steam and feed pipes are arranged to give a duplicate service between the boilers, engines and pumps. Arrangements are also made so that engines may exhaust into the air whenever the supply of water for condensing fails.

Electrical Plant.

There are four Elwell-Parker shunt-wound dynamos designed with an output of 475 ampères and 500 volts at 400 revolutions per minute; the magnets are of the double horseshoe type fixed vertically. They are divided on the horizontal centre line, so that the top half can be readily lifted off to allow of an examination or removal of the armature.

Each dynamo is coupled up through an ammeter to a double pole automatic cut-out, which also answers the purpose of main switch. All the machines are coupled in parallel on to omnibus bars, from which the current is taken by underground armoured cables to the conductors on the line.

THE CONDUCTOR.

The conductor consists of a steel channel which is carried the whole length of the up and down lines between the ordinary rails, the latter forming the return circuit. It is carried upon porcelain insulators, supported by cross timbers between the longitudinal sleepers, as shown in the drawings. The surface of the conductor is ⅞ths of an inch higher than the top of the ordinary rails. The lengths of the conductor are connected by copper pieces. At the cross-over roads the conductor is bent so as to run parallel for a short distance on each side of the ordinary rails, but leaving ample clearance to prevent arcing across. This is clearly shown in the drawing and photograph. The size and shape of the

COLLECTOR

enables it to bridge the disconnection of the conductor formed at junctions. This collector, which picks up the current from the surface of the steel channel, is practically a cast-iron shoe loosely hinged to an insulated block on the bogie.

THE MOTORS.

The motors on each train are on the leading and trailing bogies. The armatures are mounted direct upon the axles, and 10 revolutions of the axle per minute give a speed to the car of 1 mile per hour. The maximum speed necessary to do the journey in the time specified is, approximately, 26 miles per hour, or 260 revolutions of the motor per minute. The motors are series wound, and when tested with a brake, gave the torque effects on the rim of the wheels (2·9 feet diameter) :—

30	ampères	170 lbs.
40	„	300 „
50	„	450 „
60	„	650 „
80	„	1,060 „

THE TRAIN SERVICE.

A train consists of two carriages, each to seat 56 passengers. The carriages are so coupled as to give a motor at each end of the train, and the motors will be so connected together as to be controlled from either end by the driver, who will always travel at the front end, changing ends upon arrival at a terminus, and carrying with him a key, without which the motors cannot be operated.

All the carriages are exactly alike, and contain compartments for two classes of passengers, with through communication from end to end of the train, the whole being under the control of the guard. A train loaded with passengers will weigh about 40 tons. The trains will be lighted by electricity, and are fitted with the Westinghouse brake, deriving its compressed air from a reservoir on the train, the reservoir being charged after each journey. This system of working the brakes has been found to answer well on the City and South London Railway. It is intended to commence running with a five-minutes' service of trains, but the generating plant is designed to be capable of working a three-minutes' service, and the journey from end to end of the railway (inclusive of stoppages) is to be performed in less than half-an-hour. There are 13 stations upon the dock portion of the line. An experiment is to be made with automatic signals, and if successful, the innovation will no doubt result in a great saving of expense.

The total cost of the railway, including equipment, will be about £85,000 per mile.

Mr. J. W. Willans is the contractor for the works, and the Electric Construction Corporation, Limited (Wolverhampton), have provided the electrical equipment and the carriages, under the management of Mr. Thomas Parker.

The engineers, Sir Douglas Fox and Mr. Greathead, have been represented on the work by Mr. Francis Fox and Mr. S. B. Cottrell, and Mr. F. Hudleston has had charge of the work (for Mr. Willans), and to him is due the credit for the design of the tilting and swing bridges referred to.

OBITUARY.—J. E. H. GORDON.

WE feel sure the members of the electrical profession in this country have heard with genuine regret the news of the untimely and sudden death of Mr. Gordon.

He was killed on last Friday by the fall of his horse—not, as appeared in some of the papers, by a fall *from* his horse.

He was born in 1852, and educated at Eton and Cambridge.

His first bent was towards scientific research, and nine peaceful years were passed by him in this work, years not unfruitful in results in the shape of scientific papers, and one work, in its day a standard, the "Physical Treatise on Electricity and Magnetism."

His labours were not unrecognised, and we find him for two years assistant secretary to the British Association, and then appointed one of the British delegates to the Paris Electrical Exhibition of 1881.

This determined his career. His imagination was fired by the possibilities of the new illuminant; his sanguine temperament led him, overlooking the enormous practical difficulties to be overcome, to expect the immediate realisation of these possibilities, and with his courage and self-reliance (indispensable equipment of every pioneer), he believed, and rightly, as events showed, that he might play a large part in this realisation.

The general belief amongst electricians at that time was, as he himself wrote, "The day will come when gaslight will be as obsolete as wooden torches, and when, in every house, the incandescent lamp will have replaced the gas-jet." One feels that the man who wrote so believed the change to be imminent, and one knows, from memory of those days, that he was not alone in this opinion.

The fact is, that those who were in the front rank in electrical work at that time were, by the very circumstances of the case, students and scientists, and were ill-qualified to gauge accurately the magnitude of the work which lay in front of them; their confident assertions and predictions nevertheless had weight, and one remembers the panic amongst the gas shareholders, and the depreciation in the value of gas shares which ensued.

As illustrative of this, the writer remembers a story current at the time.

It appears a certain municipality owning the local gas-works very sensibly resolved to consult an expert, a deputation accordingly interviewed an eminent civil engineer (the late Sir John Hawkshaw, we have heard); his opinion was in few words, "I don't know, gentlemen, but I have bought £20,000 worth of gas shares."

Unfortunately the general public were not so well advised, and their enthusiasm (due to the Paris Electrical Exhibition) was promptly exploited by the company promoters, with the result that when—in October, 1882—the "Gordon" dynamo was set to work at the Telegraph Construction and Maintenance Company's works, at Greenwich, the industry was about to enter on a period of depression, from which it took years to recover.

These years Mr. Gordon spent in the preparation of his book, "A practical treatise on Electric Lighting," and in the inception and execution of the installation at Paddington.

One chapter in the book is noteworthy; here it is :—

Central Station Lighting.

"I had intended to write a long chapter with the above heading, but for various reasons I am not yet prepared to do so."

The materials for such a chapter did not then exist; the very possibility of the thing was doubted.

It was Mr. Gordon's task (clearly then in view) to demonstrate in brilliant fashion the possibility.

It was characteristic of the man, that one year from his first contact with practical electric lighting he should have built the then largest dynamo in the world; and so, when in 1884 he set about demonstrating the possibility of central station lighting, it was in no tentative or doubtful fashion.

It suffices here to say that the plant consisted of three 600 H.P. engines, each coupled direct to an alternate current low tension dynamo (this was before the days of transformers).

This central station was begun in 1884, and set to work on April 21st, 1886.

It was an engineering success from the start.

For any man to have conceived and successfully carried through a central station on such a scale, together with all the works involved in the conveyance of the current, and the wiring and lighting of a huge hotel, two passenger stations, a goods station and the station yards and approaches, at that time and in the then state of practical engineering knowledge would have been a remarkable achievement, which is much enhanced when one remembers that the industry was but five years old, that the work was of singular difficulty, that it was a pioneer job throughout, and that the man who did it had received no engineering training whatever, but simply the ordinary training of a public school and university.

Of the value of this success to the industry no one can be in doubt, and since it was a success steadily and determinedly worked up to through years of disaster and gloom, we may fairly grant to the memory of the man who wrought it, the meed of recognition of the boldness and magnitude of the conception and the completeness of the realisation.

For obvious reasons, inseparable from all pioneering en-

terprises, the financial results were not as satisfactory as the engineering success, and the Telegraph Construction and Maintenance Company abandoned the electric lighting branch of their business.

Mr. Gordon then, in 1887, established the Whitehall Company, which was in 1888 merged into the Metropolitan Electric Supply Company, of which he became a director and chief engineer.

For these companies he designed the Whitehall Court, Manchester Square, and Rathbone Place stations.

In 1889 he resigned the chief engineership to the company (in which he was succeeded by Mr. Frank Bailey, his able assistant since 1882), and started in business as a consulting engineer. In 1890 he formed his business into a small limited proprietary company, and started contracting.

To the years from 1890 to his death belong the central station at Sydenham (erected in an unprecedentedly short time), and the complete lighting of three Irish towns containing over 20 miles of streets.

His claim to recognition we take to be that, as a pioneer, bold, self-reliant, and successful, he rendered yeoman's service to our industry in its darkest days, and his untimely end seems to us all the more sad, for only the evening before it occurred, he, with the greatest good nature, came to assist us in some experiments we have recently been carrying out and upon which he promised his report the next day. To the widow so suddenly bereft of a husband, and the children deprived of a father's care, we offer our heartfelt sympathy.

NOTES.

South Staffordshire Tramways.—A report referring to the above electric tramways has been presented to the Board of Trade by Major-General Hutchinson and Major Cardew.

Winding up of the New York Electric Club.—The Board of Managers of the New York Electric Club have decided to wind up the affairs of the organisation.

Effect of 550 Volts.—A Chicago contemporary gives an account of the sensations of a railway electrician who by accident received 550 volts and lived. The individual referred to (Mr. Chatterton) was testing a new armature; he placed his foot upon the upper brush-holder to make a perfect contact. The current was next turned on, but the armature appeared to be running away; Mr. Chatterton's foot slipped from the brush-holder down on the commutator and whether his hand grasped the connections on the field block, or the stove, he could not say, but he knew nothing more until he regained consciousness about half-an-hour afterwards. After a couple of days Mr. Chatterton was, with the exception of a little nervousness, as well as ever. The accident had the effect of short circuiting the station, which, says our contemporary, is proof that he received the extreme 500 to 550 volts.

Accidents in America.—The *Street Railway Review* records an unusual number of fatal and peculiar accidents which occurred in America during the last few days of December. The greater number of these accidents happened in connection with horse cars. The following is our contemporary's account of one of the disasters:—"At Seattle, the day before Christmas, an electric car jumped the track, plunged into the bay, and sank. All were rescued; one passenger is probably fatally injured."

Electric Power Transmission in India.—An electric power plant has recently been erected at the Manockjée Petit Mills, Tardeo, Bombay, by Messrs. Charlesworth, Hall & Co., of Oldham, through their Indian agents, Messrs. Nowrosjee Wadia and Sons. The generator, says *Industries*, is a dynamo giving 200 ampères and 150 volts, driven by means of a rope pulley direct from the main shafting. The motor is situated at a distance of about 400 feet from the generator, and is utilised to drive the feed-parts of all the exhaust openers in the mill.

Maidstone Electric Lighting.—A report and scheme have been prepared for the Local Board by Mr. Hawtayne regarding the electric lighting question. He recommends that £16,000 be borrowed for an installation. The report is being considered.

Salford Electric Lighting.—It is now stated that the electric lighting installation at Salford will cost more than £30,000, which was the sum originally estimated. It is proposed to seek powers to borrow £50,000 instead.

Electric Safety Lamps in Mines.—It is stated, says the *Mechanical World*, that a systematic test of the behaviour of electric safety lamps in fiery mines is to be made shortly at a well-known mine in South Staffordshire.

Lectures.—On Friday, 24th inst., a lecture on "Electrical Railways" is to be delivered before the Royal Institution by Dr. Edward Hopkinson.

Lord Armstrong delivered an interesting lecture on "Electricity" before the Literary and Philosophical Society at Newcastle-on-Tyne on Tuesday last, the occasion being the celebration of the centenary of that institution.

Dundee Electric Lighting.—It is expected that the central station will be formally opened at the end of this month. A memorial has been presented to the Gas Commission from a number of the inhabitants asking for the extension of electric lighting to their neighbourhood. The matter is being enquired into as to whether the proposed extensions would pay.

Gloucester Electric Lighting.—At a recent meeting of the Corporation, a member advocated the purchase of the Gas Works, giving it as his opinion that there was a brilliant future in store for gas, and that it would never be superseded by the electric light. No resolution was moved on the subject.

Sunderland Electric Lighting. — The Corporation Highways Committee last week discussed the replies received from experts on electric lighting, who had been asked to advise the committee. Six replies were read, and they were from Prof. Kennedy, Prof. Manville, Mr. A. A. Campbell Swinton, Mr. Robinson, Mr. F. H. Medhurst and Messrs. Morgan, Williams and King. Further enquiries are to be made.

Fleetwood Electric Light.—Mr. Miller, consulting electrical engineer has lately made his report to the Fleetwood Commissioners upon his examination of the various tenders received for lighting the town with the electric light. A great number of firms had competed. It was privately resolved to recommend one of the schemes to the general meeting of the board.

Organ Blowing.—The organ at St. John's Church' Somerset, has for some five years past been blown by electricity. For some reason or other, however, the electric lighting company are obliged to stop the supply. Appeals are being made to the members of the church to contribute towards the purchase of a gas engine, as the organ is not adapted for hand blowing.

Electric Light v. Gas.—An *Irish Times* correspondent signing "Alexander Smith," recounts his "experience and opinion" of electric lighting. He started to burn it on October 21st, 1892, and a few days ago was served with a bill to December 31st for the amount of £5 10s. In addition to this, he has burned £2 worth of gas. He has come to the conclusion that electric light is a fine light for the spring, summer, and early autumn, clean and handy, but it is too dear, and, "worst of all, is too cold; it perishes a small business house, and injures goods which require heat." Thus there was another expense; for warming the place he erected a gas stove. He advises gas shareholders to stick to their shares, "no matter what people say of electricity being the light of the future—the future light is cheap gas." We had almost ventured to wonder whether he was a shareholder in the gas company.

Bury Electric Lighting.—A fresh electric lighting committee has been formed at Bury.

New Journal.—With the title of *London*, there has been commenced a new penny weekly paper which is intended to be a "journal of Civic and Social progress." The first number contains much interesting and readable matter.

Cable Between Australia and New Caledonia.—A telegram from Paris, dated 4th inst., reads as follows:—"At a Cabinet Council, held this morning, approval was given to the convention submitted by M. Delcasse, Under-Secretary for the Colonies, for laying a submarine cable between New Caledonia and Australia."

Electric Lighting in the West End.—Mr. F. J. Walker, general manager and secretary of the St. James's and Pall Mall Electric Light Company, Limited, writes to us as follows:—"With reference to certain letters which have appeared recently in the Press on the subject of the cost of electric lighting in the West End, I beg to inform you that my company has decided to reduce the standard price for the supply of electricity to all their customers from 7d. to 6d. per Board of Trade unit. Customers will further have the benefit of a sliding scale of charges extending from 6d. to 5d. per Board of Trade unit, based on the amount of electricity consumed in each case."

Obituary.—It is with regret that we announce the death, at the early age of 47, of M. Van Rysselberghe, which took place at the end of last week at Antwerp. The deceased was originally a professor at the School of Navigation at Ostend. He had also been consulting engineer to the Telegraph Department of the Belgian Government, Professor of Electrotechnics at the University of Ghent, Chevalier of the Legion of Honour and of the Order of Leopold. M. Van Rysselberghe will long be remembered on account of his ingenious inventions connected with the electrical industry.

Mr. George Mathew Whipple, superintendent since 1876 of the Kew Meteorological Observatory, died on Wednesday at Richmond at the age of fifty. Mr. Whipple had suffered for several months from a painful internal complaint. Amongst numerous papers communicated by him to the Royal Society was an important one on "The Temperature Correction and Induction Co-efficients of Magnets." The magnetic part of the report of the Royal Society, which met to discuss the Krakatoa eruption and subsequent phenomena, was written by Mr. Whipple.

St. Pancras Electric Lighting.—At St. Pancras Vestry, on Wednesday, Mr. Churchwarden Barnes presiding, Mr. Sweet, Chairman of the Electricity Committee, in moving the adoption of that committee's accounts for the year ending December 31st last, stated that the committee began with one customer only, who was not ready to receive the light as early as the committee could afford it. The result, however, of the first year's working was a total income of £11,003. Certain preliminary and the entire working expenses were £8,427. Hence there was a profit balance of £2,575. This, however, would not cover the payment of interest on, and part of principal of, the loan of £100,000 incurred as initial cost in effecting the installation. On the whole there was a deficit of £1,500. Mr. Sweet pointed out that, unlike a private commercial company, the vestry had to pay interest on capital from the commencement of the undertaking. Dr. Walter Smith, in seconding the motion, remarked that there could be no doubt that the action of the vestry in retaining in its own hands the supply of electricity to the parishioners, would certainly and soon prove very lucrative. He regarded the first year's working as a splendid success. Mr. T. Eccleston Gibb, vestry clerk, stated that for the £21,000 the Electricity Department borrowed from the vestry it had paid £901 interest. It was estimated that if the income derived from the electric current were £10,000 a year that would more than cover all necessary expenses. There was every reason to believe that the revenue would considerably exceed £10,000 per annum. Several vestrymen expressed an earnest desire that the electric light should be extended as soon as possible to other parts of the parish than those in which it already existed. The motion was adopted unanimously.

Glasgow Electric Lighting.—It is stated that the electric light will probably be turned on to Jamaica Street, Renfield Street, Union Street, Sauchiehall Street, and George Square within the next week.

The Worshipful Company of Clockworkers' Scholarship.—This valuable scholarship, entitling the holder to a five years' training at the City and Guilds Institute and the Central Institution of South Kensington, as well as to a sustentation allowance, has just been awarded to Frank Cattle, aged 13, of the St. Thomas Charterhouse Boys' School, a school which has, so far, always succeeded in carrying off this prize. The subjects of examination were:—Practical Woodwork, Mathematics, Mechanics, Perspective, other Art subjects, and general English subjects.

Derry Electric Lighting.—A meeting of the Lighting Committee of the Corporation was held last week, when the following notice was carried:—"That the sanction of the Local Government Board having been given to the application of the corporation for a loan of £15,000 at 3½ per cent. interest, the principal repayable by equal instalments in 25 years, for the public lighting by electricity of the city, including the Waterside, it is resolved that such loan be accepted, and, in order to ascertain accurately the cost of the proposed scheme, that tenders be invited for the carrying out of the works in such form that contractors can tender for the whole or any part or parts of same, the erection of the buildings for the generating station to be confined to local contractors." The motion was put and passed unanimously.

Bath Electric Lighting.—At a meeting of the Bath Surveying Committee, last Monday, it was reported that the experiment made to detect the failure of the electric light was unsuccessful, and that the company proposed to send out workmen at proper intervals each night to ascertain and report what lights were extinguished, in order that they might be re-lighted without delay. The committee recommended, under these circumstances, that the 5s. penalty under contract be enforced against the company from and after February 1st, and that the balance of account delivered by the company be paid, subject to usual deductions. Both these recommendations were adopted.

Edinburgh Electric Lighting.—It has been resolved to take further professional advice before coming to a decision whether the corporation should work the electric light order themselves or hand it over to a company. At the last meeting of the Edinburgh Town Council a motion by Messrs. Hunter and Cubie was remitted to the Cleaning and Lighting Committee to consider and report as to whether there should be public electric lighting, and if so, for what streets it would be adopted, with the view of better enabling the council to estimate what power would be required, and the system which would be most successful. Mr. Kinlock Anderson, in support of a motion by himself and Mr. Waterston to remit to the Lord Provost's Committee to consider and report as to whether the powers under the Electric Lighting Provisional Order, 1891, should be transferred to the Edinburgh and Leith Gas Commissioners, said that the Corporations of Edinburgh and Leith had entered into co-partnership in forming the Gas Commission—so constituting them the lighting authorities for the district—and if the Edinburgh Corporation entered into business to supply electric light practically in opposition to the gas commissioners or transferred their right to a company, they would violate the spirit of the co-partnery. They were, therefore, morally bound to offer the transfer of the provisional order to the gas commission whether or not that body might think proper to accept it. If they handed it over to a company, as the electric light succeeded, the interests of the gas commission would be seriously affected. Gas would increase in price, and the citizens who could not afford the luxury of the electric light would be compelled to pay dearer for gas. The commissioners were likely to introduce the electric light more economically than the corporation itself. There were certain companies applying for that order. One company in particular had made application. Were their shareholders philanthropists? ("No.") They were a body who desired to earn dividends. Mr. Waterston seconded the motion, which was passed.

Kingston Electric Lighting.—A meeting of the Ratepayers' Association was held last week, when it was resolved to call a public meeting to discuss the electric lighting question.

Exeter Hotel Electric Lighting.—The Royal Clarence and Half Moon Hotels, Exeter, have for some time past been served by the electric light company, but having recently obtained power to lay a cable between the two houses, the proprietor (Mr. J. H. Stanbury) decided to have an independent installation, and on Friday last it was inaugurated. There are 54 accumulators, which are capable of sustaining 100 16-C.P. incandescent lights for eight hours.

Maidstone and the Electric Light.—The Local Board at Maidstone is greatly concerned at the action of one of the members of the electric lighting committee, unknown, who is said to have divulged the nature of the suggestions made to the committee by the engineer whom the Board had taken into consultation in the matter of lighting the streets by electricity. The offending member was invited at the last meeting to give an explanation, but no one rose, and the matter dropped.

Society of Arts.—On Friday, February 17th, Prof. W. Cawthorne Unwin, F.R.S., will deliver his sixth lecture on the "Development and Transmission of Power from Central Stations." The following are some of the subjects to be referred to by the lecturer:—Distribution of mechanical energy by electricity; systems hitherto adopted; examples of distribution of motive power electrically; Hersthal installation; Niagara scheme; advantages of combined schemes; heat and power; light and power; water supply, light, and power.

Llandudno Electric Lighting.—The electric light has lately been introduced into Craigside Hydropathic Establishment at Llandudno, at a cost of £2,000. The number of lamps is 400. On the occasion of a dinner there last week, an experimental lecture on electricity was delivered by Mr. Kingsland. Among the guests were several of the Town Commissioners, who, it is said, attended chiefly to gain information as to the introduction of electricity for the public lighting of Llandudno.

Blackpool and the Electric Light.—Major-General Hy. Darley Crozier, R.E., conducted a Local Government Board inquiry at the Blackpool Town Hall on Tuesday last week, respecting the application of the Town Council to borrow £26,000 for electric lighting, and further sums for other purposes. The Town Clerk (Mr. J. Loftus) quoted statistics showing the increase in the population and ratable value during recent years, the latter having increased £111,000 in 16 years. He argued that many of the new companies, besides the public companies, tradesmen, and hotel proprietors would take electricity in preference to gas. The Borough Surveyor and Electrical Engineer explained the plans which were submitted. Councillor J. Pearson, chairman of the Electrical Lighting Committee, said the committee thought it most desirable for a seaside resort to have the electric light. They had recommended that it be provided for the promenade and for the centre of the town. The Mayor (Alderman J. Cardwell) concurred. Mr. Councillor Sergenson, who paid nearly £200 per annum for gas, said he should prefer to have the electric light.

A Telephone Arm Support.—The New York *Electrical Review* contains a description of a telephone arm support manufactured by the Woonsocket Edge Tool Company. This rest is equally applicable for use by a left-handed or right-handed telephone subscriber, and will permit of any movement of the body of the operator. There is no liability of the parts slipping or breaking, as they are durably constructed and connected. It may be adjusted longitudinally, vertically and laterally, and when not in use may be thrown out of the way. It is raised by simply raising the bracket or rod, and lowered by raising the outer end of the ratchet lever to free it from the shoulders of the rod, when the weight of the rest and bracket will allow it to drop to the desired point. The swivel socket allows the speaker to easily turn and speak to a person in the room without hanging up the telephone.

Fatal Accident.—A young man engaged as dynamo attendant at the Brighton and Hove Electric Lighting Company's works at Brighton was killed on Sunday night by a shock of electricity.

Electric Bills in Parliament.—At the usual sessional meeting to decide in which House of Parliament private Bills shall originate this Session, held in the House of Lords on Friday last week, it was arranged that the Brighton and Rottingdean Seashore Electric Railway and the Brighton Electric Lighting Bills should come before the Commons before going to the Lords.

Cheltenham and the Electric Light.—At the last meeting of the Cheltenham Town Council, Mr. Norman stated the Electric Lighting Committee had engaged Mr. Preece, President of the Institution of Electrical Engineers, to report on the scheme which they had placed before the Council.

Suicide of an Electrical Engineer.—On Tuesday Dr. Macdonald held an enquiry, at the St. Luke's Coroner's Court, respecting the death of Joseph Emile Lansard, aged 49, an electrical engineer, lately carrying on business at 216, Goswell Road, who committed suicide by shooting himself. The jury returned a verdict of suicide while temporarily insane.

Electric Light at Hastings.—The Mayor of Hastings has given notice "To call attention to the desirability of lighting the Town Hall and the Brassey Institute with electric light, and to move that the matter be referred to the Lighting Committee for consideration and report."

Lighting a Landmark.—A 2,000 C.P. arc lamp has been erected on the obelisk in St. George's Circus, near the Surrey Theatre. The lamp is fixed upon tall, iron supports, attached to the apex of the obelisk, which has been strengthened by iron clamps for the purpose.

Singapore and the Electric Light.—The Municipal Commissioners of Singapore, at a recent meeting, rejected an offer from a Mr. Thomas to supply "a certain number" of arc lamps for the lighting of the town—which under existing conditions is said to be very badly done—at a cost of $950.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—February 20th. For the supply of telegraph stores, &c., for one year from March 1st next. Further particulars from the Storekeeper, Belfast.

London.—March 1st. 60,000 carbons for electric lighting for the Great Western Railway. Full particulars will be found in our advertisement pages.

Londonderry.—March 1st. For the supply and erection of boilers, engines, condensers, steam and water pipes, dynamos, &c., including complete installation for street lighting for the Corporation. H. W. Blake, engineer. Further particulars from Mr. R. N. Chambers, Town Clerk, Guildhall, Londonderry, Ireland.

Mons (Belgium).—No date. For installation, &c., of electric lighting at Mons Station for the Belgian State Railways (Brussels Bourse).

Nottingham.—February 16th. For the supply and erection of boilers at the Wollaton Street electric station for the corporation. Further particulars from the electrical engineer, Town Hall, Nottingham.

Warrington.—February 14th. For the erection and maintenance of telephones, wires, &c., for the Warrington Town Council. Further particulars from Mr. J. Lym Whittle, Town Clerk, Town Hall, Warrington.

CLOSED.

Dundee.—The special committee have recommended the Town Council to accept the tender of Messrs. Lowdon Brothers (£79 15s.) for fitting up the Parochial Board offices for electric lighting. There are to be erected 89 lamps of 16 C.P.

Melton, Suffolk.—The tender of Mr. George Jennings, Lambeth, London, S.E., has been accepted for an installation of Jennings's & Brewer's electro-mechanical apparatus to indicate and record in the engine house of pumping station the variations at every inch in level of the water in the tower tank at the Suffolk County Asylum.

Plymouth.—The Water Committee of the Plymouth Corporation have accepted the tender of Mr. Francis Dagger for the renewal of their telephone line between Hartley and Roborough.

BUSINESS NOTICES, &c.

Windsor Electrical Exhibition.—An electrical exhibition was held on Wednesday and Thursday last week at the Albert Institute at Windsor, under the auspices of the local Scientific Society. In conjunction with the Windsor Electrical Supply Company this society arranged the exhibition, in which they were assisted by several well known London firms. Two 1,000 C.P. 10 ampère Phœnix arc lamps burning excellently in series on the 100-volt circuit, were exhibited by Messrs. Paterson & Cooper, of 68, Victoria Street, S.W. On entering the hall there was observed an arc lamp with the carbon points focussed on to a screen to show the crater of the arc. Near this were fixed the main distributing switchboard and measuring instruments to which the company's main cable was taken. These were kindly lent by Messrs. Paterson & Cooper, and the switchboard was of their usual type, with lever switches on enamelled slate and double-pole fuses to each circuit. The mains were carried from the company's last junction box in the High Street, across the intervening gardens into the back of the Institute. Next to the switchboard there was an exhibit by Mr. Dunning, of Windsor, who represented four firms, viz., Messrs. Drake & Gorham, who showed their Cardew voltmeter, ring contact switches, earthing device, and measuring instruments; the Walsall Company, who showed measuring instruments and cell testing voltmeters. Messrs. Laing, Wharton & Down, who showed their patent automatic regulator; Messrs. Benham & Froude showed samples of their artistic fittings. The next stand was that of the Electric Company of Charing Cross Road, who had some table lamps and wall brackets, and also a sewing machine driven by an electric motor, and some cooking apparatus. Messrs. Paterson & Cooper exhibited a very large and varied assortment of apparatus and fittings. Under the gallery there was a very artistic room managed by Mr. A. Harris, of Messrs. Roger Dawson's. The refreshment tables on the stage were decorated with incandescent lamps arranged among the flowers, &c., by Mr. Rashleigh Phipps and Messrs. Paterson and Cooper's representatives.

The West End Electric Lighting.—Since our last report we notice that Messrs. Vaughan & Brown, of Kirby Street, Hatton Garden, E.C., are fitting up the residence of Dr. Waugh, 86, Wimpole Street. Fitting and wiring contracts have recently been completed in the premises of Mr. John Sparks, the Japanese Fine Art Depôt, Duke Street; one for Mr. Bolton, 89, Wigmore Street; the Arctic Fur Stores, 317, Regent Street; one for Mr. S. Reid, 161, Oxford Street, &c.—Messrs. Bertram & Co., of Dean Street, Oxford Street, are engaged upon work at 39, Berkeley Square; while Edmundsons, Limited, of Great George Street, Westminster, are engaged upon a contract at a new residence situate at 47, Berkeley Square.—A large number of new residential premises are at present being erected in Mount Street, W., all of which will be lighted by electricity.—Messrs. Gilbert & Co., of Hanway Street, W., are fitting up the premises of Messrs. Bullock & Co., 3, Hanover Street.—Electric lighting work has also been completed in the premises of Messrs. Stimson, 9, Hanover Square; Messrs. Joel, Edwards & Sons, 9, Hanover Street; Messrs. Erard, 18, Great Marlborough Street, and Mr. C. H. Fox, Wellington Street.—Messrs. Edmundsons, Limited, have secured the contract for fitting up the premises of Messrs. Louise & Co., 210, Regent Street.—Messrs. Rashleigh Phipps & Co., of Oxford Street, are carrying out work at 71, Oxford Street.

Marked Progress in Process Engraving.—Messrs. Meisenbach & Co. have sent us a specimen of their improved process of photo engraving in the form of a political calendar for 1893. The subject, entitled "Queen of Flowers," has been engraved from the coloured supplement to the *Lady's Pictorial* Christmas Number, a picture of 21 printings, and is an example of monochrome reproduction from paintings and colour work by their "special orthochromatic process," which gives a most accurate representation of the picture, as regards the colour value, in light and shade. Round the border are photos of over 600 of the members of the present Parliament. It will be observed that, notwithstanding the minute size of the portraits, each is distinct and clear. The fineness of detail is far beyond the skill of ordinary hand engraving, and it is questionable whether it would be possible to produce a type printing block giving equal results by any other known method of engraving. The calendar is a unique specimen of process engraving. It is a splendid piece of work, and indicates the progress being made in this class of engraving, especially in regard to the exceedingly small portraits round the border, which are so clearly printed.

Private Electric Lighting.—The following are some of the installations at present being carried out by Messrs. Cathcart, Peto and Radford:—Complete plant and installation of 100 lights at country house of Frank Lloyd, Esq., Croydon; new plant at Wilson's tea shop, Croydon; complete plant, dynamo, &c., at 114, Tooley Street; complete plant at Messrs. Burton's, Bethnal Green; wiring at 232, Edgware Road; wiring at 91, Brompton Road; installation at "Globe" Restaurant, Hatton Garden. Above work is all in course of completion.

The Blockley Electric Lighting and Manufacturing Company, Limited, last week completed the electric lighting of Mr. Justice Kekewich's house at 19, Park Crescent, Portland Place, W., and the work has been pronounced a great success. The fittings are by W. A. S. Benson & Co., and Richard Crittall.

An electric lighting installation has been fitted up at Mr. J. H. North's offices at 110, Grafton Street, Dublin. The contractors for the work are the Electrical Engineering Company, of Ireland.

Catalogues, Calendars, &c.—We have before us a copy of a new catalogue which has just been published by Messrs. J. M. Bennett & Sons, of Manchester. The book deals with the Goehring Mouldings, which class of work we understand is very effective when applied to covers for electric light casings. As a catalogue it is a thoroughly good one, being a complete and first-class compilation, beautifully printed on nice paper. At the beginning are given particulars regarding, and photos of, the members of the firm back to its commencement, considerably more than a century ago. Illustrations are very numerous, and there is a great deal of information for the timber people. At the end of the book are a number of testimonials. We have also had samples of the "Goehring" mouldings sent to us.

The General Electric Power and Traction Company have sent us a copy of their illustrated list of "Compound-wound dynamos for mining and general work, wound for 100 to 500 volts," also one of their loose price sheets of "Immisch" ring armature motors for continuous running.

We have received one of the latest card-lists of the Wray Electrical Engineering Company. There is illustrated on this list the Patent Soho dynamo and motor, of which particulars and prices are given. On the back is a list of a few of the installations carried out by the company.

Lists of patent vulcanised fibre and insulating saddle staples for electric wiring, have been sent to us by Messrs. Mosses & Mitchell, of Chiswell Street, E.C.

Messrs. Crompton & Co., Limited, have just brought out a new catalogue in which are given some notes, data and prices relating to dynamos, generators and motors of their manufacture. In the opening pages of the book is a handy telegraph code, and following this are some carefully prepared particulars of Crompton dynamos and motors. Full page illustrations are also here given of the Crompton patent dynamo, types B and C, as well as a price list of dynamos for incandescent lighting. A list of the dynamos and motors in stock on January 1st, 1893, ready for immediate delivery, and a further number of illustrations, as well as numerous other particulars of interest, are included in the book, which is on the whole a very complete catalogue, and should be very serviceable to Messrs. Crompton's customers.

An Electrical Engineer's Failure.—Under the failure of Harry Bury, electrical engineer, late of Bury New Road, and Arcade Chambers, Manchester, accounts have been filed at the London Bankruptcy Court showing gross liabilities £509 9s. 10d., of which £328 5s. 10d. are expected to rank against assets, £35 6s. The debtor states that the Manchester business was closed in March, 1889, and the whole of the liabilities then outstanding, and amounting to about £600, were discharged, with the exception of £35, with money given to him by his friends. He shortly afterwards removed to London, and he attributes his insolvency to liabilities in connection with accommodation bills, and to law costs and expenses in an action brought by him in respect of an alleged defective dynamo supplied to him in 1880. The books of account were either lost or destroyed on leaving Manchester in 1889.

The Brush Electrical Lighting and Engineering Company v. The Douglas Grand Hotel, Theatre, and Baths Company, Limited.—In the Douglas High Court of Justice, before Deemster Sir W. L. Drinkwater, on January 30th. This suit was brought to recover £305 11s. 3d., the balance of the amount due for supplying the electric light to the defendants' premises. Mr. Lay appeared for the plaintiffs, and Mr. Ring for the defendants. Mr. Lay to Mr. Ring: Do you admit the claim?—Mr. Ring: No, certainly not. Negotiations are going on with a view to settling the dispute between the parties. If I put in my defence before Wednesday week will that satisfy you?—Mr. Lay asked that the defence be put in within seven days, and it was eventually agreed that that should be done. His Honour also granted Mr. Lay's application for a commission to Manchester.

Chicago Exhibition.—For the convenience of visitors to Chicago during the forthcoming exposition, a mammoth hotel is being erected by the World's Fair Co-operative Bureau. The hotel is in blocks, somewhat after the plan of St. Thomas's Hospital, and will contain over 6,000 rooms. These rooms will be let at a uniform rate of a dollar a day to those who pay a nominal registration fee beforehand, and thus secure the right of occupancy at any time during the Exposition. The sole representation of the World's Fair Co-operative Bureau in Great Britain has been placed in the hands of the City Press Agency, 1, King's Arms Yard, and 51, Coleman Street, London, E.C.

The Varley's Electric Patents Proprietary, Limited.—A general meeting of the members of the above named company will be held at the offices, 527, Mansion House Chambers, on March 14th, 1893, at twelve o'clock, noon, for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator.

Colliery Electric Lighting.—Loanglea Colliery, West Calder, has a complete electrical installation for lighting, hauling, and pumping. The dynamo, motors, cables, lamps, were supplied by Mr. Wm. M'Whirter, of the Faraday Electrical Works, Govan.

The Square Drilling Machine Company.—This company have now established works at Aberdeen Street, Nottingham, where they have commenced the manufacture of their patent drills, and general drilling and milling machine tools.

Personal.—Mr. J. H. Leadbetter gives notice that he has withdrawn from the firm of McInnes, Leadbetter & Co., electrical engineers, Leicester.

May's Patent Watch Shape Revolution Counter.—Where machinery is running it is frequently necessary to determine the number of revolutions. The illustrations show May's new patent revolution counter, which takes the shape of a pocket watch, and is therefore conveniently portable. The watch case keeps the works

FIG. 1.

well protected and clean. To secure an easy reading, the face is silvered, and the figures are kept bold and black. The revolutions are read off a dial like on a watch by two arbors, the long one reading hundreds. The instrument is so constructed that whichever way the

FIG. 2.

machinery revolves—to the right or left—it is direct reading. There is a disc under the face with a double set of figures, and these figures become visible through the apertures in the face automatically, in accordance with the direction in which the spindle revolves. Fig. 1 shows the spindle turning to the right, whereas in fig. 2 the direction is to the left. It is obvious to everybody that both figures read 738 revolutions. By a key inside the back cover both arbors are easily placed back to zero. Messrs. O. Berend & Co., of 61, Fore Street, are the owners of the English patents.

CITY NOTES.

The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

THE directors' report for the year ending December 31st, 1892, to be presented at the twenty-ninth ordinary general meeting of the shareholders, to be held at the Cannon Street Hotel on Tuesday, 14th inst., at 12 o'clock noon, reads as follows:—

"The annexed accounts show the net profit for the past year to be £99,161 11s. 7d. Adding £42,073 5s. 10d. brought forward, and £43,110 premium on 8,400 new shares issued in March, and deducting £25,000 interim dividend paid in July, there remains a disposable balance of £159,344 17s. 5d. Of this balance the directors have added to the reserve fund £75,000 (including the premium on new shares), and recommend the distribution of a dividend of 10s., and a bonus of 5s. a share, free of income tax, amounting to £37,500, making, with the interim dividend, a total payment for the year of 12½ per cent., and leaving £46,844 17s. 5d. to be carried forward. The company's ordinary business continues satisfactory. The principal cable work of the year has been the completion of the manufacture and the laying of about 2,200 miles for the South American Cable Company, and the manufacture of about 2,600 miles for the Central and South American Telegraph Company. The steamship, *Silvertown*, sailed on the 22nd of last month to lay the latter cable between Peru and Mexico. The works and machinery at Silvertown and at Persan-Beaumont are in the usual state of efficiency. Mr. S. Wm. Silver and the Hon. Henry Marsham, the directors retiring by rotation, offer themselves for re-election. Mr. J. Weise, of Messrs. Turquand, Youngs, Weise, Bishop and Clarke, retires from the auditorship; but Mr. J. F. Clarke, of the same firm, offers himself for election in his place.

BALANCE SHEET, December 31st, 1892.

CAPITAL AND LIABILITIES.

Dr.	£	s.	d.
Amount of authorised share capital	812,000	0	0
To Share capital—Amount subscribed and paid on authorised issue of 50,000 shares of £10 each	500,000	0	0
„ Mortgage debentures	200,000	0	0
„ Reserve fund	400,000	0	0
„ Steamers' maintenance fund	10,000	0	0
„ Debts owing by the company and suspense account	77,438	16	9
„ Unclaimed dividends	294	0	0
„ Proposed dividend of 5 per cent., and bonus of 2½ per cent.	37,500	0	0
„ Amount carried forward to 1893, as below ...	46,844	17	5
	£1,272,077	14	2

ASSETS AND EXPENDITURE.

Cr.	£	s.	d.
By Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery and steamships	489,745	1	2
„ Debts owing to the company	105,489	7	1
„ Cash with bankers, on deposit, and in hand ...	63,327	3	10
„ Bills receivable	9,176	3	1
„ Stock-in-trade, including cable and expenditure on account of contracts	221,121	16	8
„ Debentures and shares in other companies ...	227,865	15	0
„ Cash, stock, &c., at Persan and other agencies ...	155,352	7	4
	£1,272,077	14	2

PROFIT AND LOSS ACCOUNT for the Year ending December 31st, 1892.

Dr.	£	s.	d.
To Salaries, interest, rent, rates and taxes, repairs, and general expenses	67,853	7	4
„ Bad debts	1,250	10	3
„ Income tax	1,800	14	0
„ Depreciation written off buildings and machinery	15,700	7	6
„ Directors' remuneration (minimum)	2,000	0	0
„ Balance—Profit for the year, carried down ...	102,161	11	7
	£190,766	10	8
	£	s.	d.
To Addition to reserve fund	75,000	0	0
„ Interim dividend of 5 per cent. paid in July, £25,000; proposed dividend of 5 per cent., £25,000; proposed bonus of 2½ per cent., £12,500	62,500	0	0
„ Balance to be carried forward to 1893	46,844	17	5
	£184,344	17	5

Cr.	£	s.	d.
By Gross profit, including interest on securities, and after charging commission	190,766	10	8
	£190,766	10	8
	£	s.	d.
By Balance brought down, £102,161 11s. 7d.; *less* additional remuneration due to directors after payment of 10 per cent. to shareholders, £3,000...	99,161	11	7
„ Premium on 8,400 new shares issued	43,110	0	0
„ Amount brought forward from 1891	42,073	5	10
	£184,344	17	5

I have examined the above accounts with the books and vouchers and the returns from the Persan and other agencies, together with the securities representing the investments held by the company, and certify to their correctness in accordance therewith. The subsidiary books have, as usual, been examined in totals; and I have had produced to me the inventories of stocks on hand, certified by the works manager.

J. WEISE, *Auditor.*

London, *February 3rd*, 1893.

The Kensington and Knightsbridge Electric Lighting Company, Limited.

THE directors' report to be presented at the sixth ordinary general meeting to be held at 1, Great George Street, Westminster, on Thursday next, 16th inst., at 5 p.m., reads as follows:—"The directors submit to the shareholders a statement of the accounts of the company, together with a report of the position of the undertaking at the end of the year 1892. The mains, which extended for a length of 12¼ miles in the previous year, have been increased during the year 1892 to 13 miles, and many of the existing mains have been increased in sectional area. During the year the number of houses and shops connected with the system has increased from 436 on December 31st, 1891, to 550 on December 31st, 1892; while the number of lamps calculated on the usual basis of 8-candle-power, has increased from 38,408 to 47,441. The improvement in the efficiency of working the plant, reported as being made at the last meeting, has been maintained throughout the year. In view of the increase in the business of the company from the present district, and in contemplation of the increase from the area mentioned below, the plant at Kensington Court and at Chapel Place has been extended and further machinery is on order. Negotiations are pending, and, subject to the approval of Parliament, may be regarded as practically concluded, for the transfer to this company of that portion of the Parish of St. Mary's Abbotts, Kensington, which is at present served by the Chelsea Electricity Supply Company, Limited. The transfer cannot be carried into effect without the sanction of Parliament, and the necessary Bill has already been approved by the shareholders in two successive meetings and has been introduced into Parliament. This transfer, if sanctioned, will add to the company's area of supply an important district, which in the opinion of your directors will materially improve the company's position. The dividend on the 6 per cent. preference shares was duly paid to June 30th, 1892, and an interim dividend at the rate of 4 per cent. per annum was paid on the ordinary shares for the first half of the year, and out of the balance standing to the credit of the net revenue for the year 1892, £3,792 13s. 5d., the sum of £1,462 10s. has been appropriated for the payment of the preference dividend to the end of the year, leaving £2,330 3s. 5d., out of which it is proposed to pay a further dividend on the ordinary shares at the rate of 4 per cent. for the past half-year, leaving a balance of £867 13s. 5d. It will be observed that no provision has been made in the accounts for directors' remuneration. In accordance with the articles of association, Mr. G. H. Hopkinson and Mr. Granville R. Ryder, retire from the directorship, and being eligible offer themselves for re-election. The auditors Messrs. Lovelock, H. W. Whiffin and Dickenson offer themselves for re-election."

ABSTRACT OF ACCOUNTS to December 31st, 1892.

REVENUE ACCOUNT.

Dr.	£	s.	d.
To Generation of electricity	3,746	11	4
„ Proportion of rents, rates, and taxes	898	18	3
„ Repairs, insurance, &c.	93	6	7
„ Proportion of law and parliamentary charges	895	5	3
„ Bad debts	3.3	6	9
„ Auditors (special item)	90	10	0
„ Salaries	975	12	6
„ Lamps	117	18	3
„ Renewal account	3,395	15	7
„ Sinking fund	108	0	0
„ Balance	6,828	7	8
	£17,538	12	2

Cr.	£	s.	d.
By Sale of current per meter } less rebates	16,628	14	2
„ „ „ under contract }			
„ Rental of meters, converters, &c.	577	17	11
„ Transfer fees	2	10	0
„ Other items	329	10	1
	£17,538	12	2

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Interest on temporary loans, £11 14s.; interest on debentures, £957 8s. 10d.	969	2	10
„ Dividends 6 per cent. on first preference and 4 per cent. on ordinary	2,925	15	4
„ Balance	3,792	13	5
	£7,687	11	7

Cr.	£	s.	d.
By Balance from account, less dividends on preference and ordinary shares for 1891	848	1	3
„ Interest	11	2	8
„ Balance from revenue account	6,828	7	8
	£7,687	11	7

RENEWAL ACCOUNT.

Dr.	£	s.	d.
To Maintenance of buildings, plant, &c.	2,124	15	7
„ Plant written off, less cash received for material	921	0	0
„ Balance	2,063	5	0
	£5,109	0	7

Cr.	£	s.	d.
By Balance from last account	1,713	5	0
„ Amount brought from revenue account	3,395	15	7
	£5,109	0	7

GENERAL BALANCE SHEET.

Dr.	£	s.	d.
To Capital account	154,400	0	0
„ Sundry creditors and open accounts	3,011	14	4
„ Net revenue account	3,792	13	5
„ Renewal account, balance at credit thereof	2,063	5	0
	£163,267	12	9

Cr.	£	s.	d.
By Capital account	152,217	12	4
„ Preliminary expenses and cost of debenture issue	842	3	6
„ Cash at bankers }	819	16	9
„ „ in hand }			
„ Sundry debtors	6,859	7	0
„ Stores on hand	379	9	4
„ Suspense account, less amount debited to law charges	1,600	0	0
„ Consols	549	3	10
	£163,267	12	9

Brush Electrical Engineering Company. — The directors of the above company have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. (the maximum which, according to the articles of association, can be paid as an interim dividend) on the ordinary shares of the company, for the six months ended December 31st, 1892, payable February 27th, 1893. The transfer books of the company will be closed from the 13th to the 28th inst., both inclusive. In view of the interest payable March 1st, 1893, on the debenture stock of the Brush Electrical Engineering Company, the debenture stock transfer books will be closed from February 20th to March 2nd, 1893. Mr. Emile Garcke, having accepted the appointment of managing director to the Electric Construction Corporation, Limited, has resigned his seat on the board of the Brush Electrical Engineering Company, Limited.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the City and South London Railway Company, £7,000 perpetual 5 per cent. preference shares. To allow the following to be quoted in the Official List:—City and South London Railway Company, £30,000 additional ordinary stock.

Telegraph Construction and Maintenance Company.—Subject to the audit of the accounts, the directors propose paying a dividend of 10 per cent. (£1 4s. per share) in addition to the 5 per cent. already paid, making 15 per cent. for the year 1892.

Cuba Submarine Telegraph.—The directors recommend a dividend at the rate of 8 per cent. per annum for the six months ended December 31st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending Febuary 5th, 1893, amounted to £956; week ending February 7th, 1892, £824; increase £132; total receipts for half-year, 1893, £4,910; corresponding period, 1892, £4,152; increase £758.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of January were £3,800; as compared with £3,518 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of January, 1893, amounted to £1,901, against £2,195 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in January, 1893, amounted to £20,800; corresponding month, 1892, £20,000; corresponding month, 1891, £20,800.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 3rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,559.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation February 2nd.	Closing Quotation, February 9th.	Business done during week ended February 9th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 — 103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	53½— 54½	54 — 55	54½	...
2,876,140*l*	Do. do. 6 p.c. Preferred	Stock	95½— 96½	96½— 97½	96⅝	96
2,876,140*l*	Do. do. Deferred	Stock	12½— 12⅝	12⅝— 13¼	13	12 11/16
130,000	Brazilian Submarine Telegraph, Limited	10	11¼— 11⅝	11¼— 11⅝	11⅝	11⅝
34,600*l*	Do. do. 5 p.c. Bonds	100	99 —102 xd	99 —102	...	...
75,000*l*	Do. do. 5 p.c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½— 3⅝	3½— 3⅝	3 5/16	3¼
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅜— 2⅝	2⅜— 2⅝	2½	2¼
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	103 —105	104 —106	105¼	103¼
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	37 — 39	37 — 39	38	37
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11⅞— 12¼	12⅛— 13	12⅜	12 1/16
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	7⅞— 8¼	7⅞— 8¼	8 3/16	8
$7,716,000	Commercial Cable, Capital Stock	$100	175 —180	175 — 180	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16— 5/16	3/16— 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½	5 — 5½	...	..
16,000	Cuba Telegraph, Limited	10	12 — 13	12 — 13	12½	12⅜
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	18¾	18¼
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2 — 3	2 — 3	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅝— 11⅞xd	11⅝— 12	11 15/16	11 11/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14⅜— 15	15	14⅜
70,000	Do. 6 p. c. Preference	10	15½— 16½	15½— 16½	16¼	15 15/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109 xd	106 —109	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	111 —114	111 —114	113	112¼
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
70,600*l*	Do. 5 p. c. (Aus. Gov Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	1 3 —106	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	104	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112 xd	109 —112	110½	110
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104 xd	101 —104	102⅜	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2¼— 2⅜	3 — 3½	2⅜	2⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/16— 1/4	3/16— 1/4	...	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/16— 1/4	3/16— 1/4	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/4— 1/2	1/4— 1/2	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 10	9⅜— 9⅞	9 15/16	9⅜
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜— 19¼	18⅜— 19¼	19⅜	19
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	..
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½— 7½	6½— 7½	..	..
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22½— 23½	22½ - 23½	23¼	22 15/16
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 45	43 — 45	44½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ..	10	6 — 7	6 — 7		
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 — 4¼	4 — 4¼	4⅛	4 1/16
10,000	Do. do. fully paid	5	5⅜— 6	5⅜ — 6	6	5⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	..
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½— 7	6½— 7	6 15/16	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	104½	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	5½— 5⅝	5½ - 5½	5 7/16	5¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½— 15½	14½— 15½	14½	14 13/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¾— 14½	13¾— 14½	14 1/16	14
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4½— 4⅝	4⅝— 4⅝	4½	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —115	112 —115	114¼	113¾
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5½— 6½	5½— 6½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/8— 1/4	1/8 — 1/4	...	.
11,802	Reuter's Limited	8	7½— 8½	7½ 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¾— 8¼xd	7¾ - 8¼	...	..
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8¼xd	8 — ⅛	...	...
3,381	Submarine Cables Trust	Cert.	120 —125	119 - 124	120½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 3½	3¼	3 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	36 - 40	47	37
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 104	102¼	102⅛
58,000	United River Plate Telephone, Limited	5	2½ - 3	2½ 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ..	Stock	90 —100	90 - 100	...	.
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ - 7½	6½ 7½	...	..
260,900*l*	Do. do. do. 5 p. c. Debentures	100	102 —105	102 105	104½	103¼
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	2½ 3½	.	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105	102 - 106	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7⅞— 8¼	7⅞ 8¼	8¼	8
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 6¼	5½ 6¼	6⅛	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅞— 2¼	1⅞ 2¼	2¼	2 1/16
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107 xd	104 1 7	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107 xd	104 - 1 7	107	106
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½ 1⅝	1 11/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10½— 11	10¼— 11	10⅜	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½	8½ - 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	103 —106	103 —106	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼	5⅜ — 6¼	6 1/16	5⅜

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 2½ per cent. (January 26th, 1893.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅜—7⅝.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—Elmore Foreign and Colonial Copper, Founders shares, 6¾—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6½.—Liverpool Electric Supply Shares of £5 (fully paid), 5½—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ½—1½.

A NEW INCANDESCENT LAMP CLAIMANT.

SURPRISES are not over in the way of claimants for priority to the first incandescent electric lamp. If what we learn from the numerous affidavits which are published in the *Electrical Engineer* (New York) for January 25th, and from an article in the same issue by Mr. F. L. Pope, is to be credited, Edison, with his claim to the high resisting carbon filament, the all-glass vessel, platinum wires and vacuum, is nowhere in comparison with Henry Goebel. True, there are some points in the strange tale we are about to recount that are open to severe criticism, but, on the other hand, unless some 28 witnesses are unanimous in committing wholesale perjury—and is man, collectively, still so depraved as this?—it is difficult to be wholly sceptical. The tale, in brief, is as follows :—

Heinrich Goebel was born near Hanover in 1818. He adopted the trade of a watchmaker and optician, and in the course of his business became interested and familiar with physical science. Amongst others who encouraged him in this pursuit was a Prof. Moninghausen, and with this gentleman he frequently discussed the problem of making an electric lamp; J. W. Starr's efforts in this direction being at the time (1846) published in the technical journals in Europe. They even went so far as to make some experiments together, but without successful results. In 1848 Goebel found his way to New York and established himself in an out-of-the-way quarter of that city. Here he remained 20 years, and managed on the proceeds from his small shop both to support his family and carry on his favourite occupation of making experiments and apparatus. Amongst other things, he continued to work at electric lamps, and by 1855 had made quite a number of lamps of various forms, which he ran on a zinc carbon battery, of his own construction, of about 30 cells. The lamps were made out of pieces of glass tube, and had three principal forms. One of these, the meat saw type, contained two parallel wires sealed into one end of the tube, one wire being long and the other short, with the filament stretched between the ends and supported thereto by spirals filled with black lead cement. Another variety was similar in form, but the filament was in the shape of a spiral spring; while the hairpin type was a simple loop, with which every one is now familiar. The filaments, which were about $\frac{8}{1000}$ inch in cross section, were splints of bamboo, or tampica, and were baked in a plumbago crucible, and heated in a cooking range. Supporting wires of platinum, iron and copper, were tried, the first-named being usually cuttings or scraps on account of their cheapness; and these were sealed into the tube by heating in a foot blow pipe, and pressing the softened glass on to the wires. The vacua were at first made by joining a long glass tube to the lamp, filling both with mercury, then inverting over a bowl of mercury, and finally sealing off the empty lamp with a blowpipe. Later, however, a mercury pump of Goebel's invention and make was apparently used. These lamps when run on a battery lasted a short time and gave a brilliant and beautiful light, and some of them are even now in existence. They were used in the little shop occasionally, one device being to light up the dial of a clock at each succeeding hour. But the most public use that was made of the lamps was in connection with the exhibition of a large telescope, again of Goebel's make, that he wheeled about on a waggon to various parts of the city on starlight nights, for the purpose of collecting small fees from passers by who were induced to peep through it at the wonder of the heavens. This truck contained, in addition to the telescope, a battery and two or three incandescent lamps, which were occasionally lit up to attract the public. These exhibitions occurred prior to the war in 1860. From this time up to 1881 Goebel seems to have continued amusing himself by making lamps, and in that year we next hear of him as sought out by a Mr. Crossby, of the American Electric Light Company, an early short-lived concern, that started making lamps in opposition to Edison, with the result that he was engaged by the company. He was found to be far better acquainted with the details of manufacturing lamps than the rest of the company's staff.

If there is any truth in the story, it is a most singular thing how it has happened that Goebel and his lamp should only now be emerging from obscurity. Nothing is mentioned of his career since 1881, and it seems incredible that he (or at any rate some 'cute individual for him) should not have announced his claim to priority long ere this, to say nothing of the fact of his not having thought of patenting his lamp. Mr. Pope explains the latter circumstance by his knowing quite well that so long as a battery had to be used as a source of electricity, the lamp could never be used commercially, and that owing to his circumstances and surroundings the applicability of the dynamo for the purpose did not come to his knowledge. But we confess this explanation does not altogether satisfy us. Goebel appears to have made no kind of secret of his lamp labours, though he was at one time connected with a friend in patenting a certain hemmer (? hammer). He was therefore alive to the process of patenting.

All these incidents have been gathered together by the Beacon Lamp Company, who were sued the other day by the General Electric Company for infringing the Edison patent, and the Court was taken entirely by surprise by the above revelations, which are corroborated by a host of witnesses, amongst whom are Goebel's children, friends and acquaintances who knew him intimately, and some of whom helped him in his lamp making experiments. Mr. Dyer, who appeared for the General Electric Company, however poohpooed the whole story on the ground that had the supposed invention been known to so many persons, it must have become generally known long before this. Further, he was prepared to prove that the Goebel matter had been in the possession of the Westinghouse Companies some months back, but they had not found it desirable to try and use it. Mr. Fish, on the same side, also spoke of being able to produce two affidavits later in the day to rebut the mass of affidavits produced for the defence. Mr. Willer, who followed, urged, on the other hand, in a long speech, the entire probability of the story. The case was to be resumed on January 31st.

A LARGE SWITCHBOARD.

ONE of the handsomest and largest switchboards in the world has just been completed at the Schenectady works of the General Electric Company for the first station of the Edison Electric Light and Power Company of San Francisco.

It is constructed of slabs of highly polished white Italian marble mounted on an iron frame, and is 56 feet 8 inches in length.

The board provides for the distribution of 2,200 kilowatts, or 14,666 ampères at 150 volts, from 12 generators of the General Electric Company's multipolar type, directly coupled to triple expansion engines. Ten of these dynamos are of 200 kilowatts; two are of 100 kilowatts capacity, and all are arranged on the three-wire system.

The main and auxiliary busbars run the entire length of the switchboard and are set in a rack in the rear. They are so arranged that they can be cut in two at the centre by means of heavy switches on the face of the board. This allows of the operation of the station under four different potentials at the same time.

Provision is made for 24 feeders. Each feeder is equipped with two ampèremeters and three switches. Each switch has two blades, one for the main and one for the auxiliary bus, the positive and negative switches of each set being provided with safety catches.

A novel feature in these last named switches is the mica covering for the fuse, which is hinged and can thus be readily raised where necessary for the insertion or adjustment of the fuse.

A special 30 point indicator switch is mounted on the board by means of which it is possible to read in the station the voltage at all the feeding points in the outside system.

Each dynamo is provided with an ampèremeter, a dynamo field regulator and two switches, each double-bladed, so that the dynamo may be thrown upon either the main or auxiliary busbar.

The ampèremeters are mounted on bases of marble similar to that of the board, and have highly finished brass covers

with fronts of bevelled heavy plate glass. The regulators are also fitted with white marble tops.

Besides the apparatus already mentioned, the board is equipped with the necessary pressure and galvanometer switches.

Two ornamental pillars, supporting small auxiliary boards, are to be erected at either end of the board. Upon these will be placed the dynamo galvanometers and pressure indicators.

All connections are made at the back of the switchboard. Those between the instruments and the busbars, are through flexible copper cable of 1,500,000 circ. mils cross section.

The following items relating to the work on the board may prove of interest. The board is built up of 26 marble slabs each of about 25 square feet of surface and weighing in the aggregate over 7½ tons. The weight of the main switchboard complete and fitted for the present requirements of the station, is 37,000 lbs. 5,000 lbs. of copper connecting cable, 6,000 lbs. of copper busbar, and 10,000 lbs. of high conductivity metal were used in its construction.

Each dynamo switch of 1,500 ampères capacity weighs 150 lbs., each double-bladed feeder switch 100 lbs., and the large busbar switch 200 lbs.

When the switchboard is erected in its place in the station at San Francisco, it is to be further adorned by the addition of an ornamental cornice and base board.

From the above description the magnitude of the task undertaken by the General Electric Company can be appreciated. It called for unusual resources, the floor space alone necessary for its erection being equivalent to that of a moderate sized factory. Such excellent workmanship, both electrically and mechanically, marks an advance in the electric art, and to the Engineering Department of the General Electric Company at New York, which designed this board, should be awarded the meed of credit which is its proper due.

ELECTRIC LIGHT AND GAS.

By Ed. C. DE SEGUNDO, Assoc.M.Inst.C.E.

(*Continued from page* 90.)

In the preceding article it was shown that the local generation of the necessary electrical energy for lighting purposes was expensive, and that the smaller the installation the higher the cost of maintenance per unit. It is possible, indeed probable, that if the installation is large enough, the electric light could be produced at a less expense (cost of generation and supply and allowance for interest, depreciation, &c.) than the cost of gas at 3s. per thousand for an equivalent lighting effect. It is stated, for instance, that the total cost of lighting Madame Tussauds' Exhibition by gas power is less than the cost of an equivalent gas supply for equal light. The amount of electric light is equivalent to 1,500 8-C.P. lamps, burning on the average 1,500 hours per annum.

Subjecting this to our former methods of calculation for the sake of uniformity, we have

$$(1.)\quad 1{,}500 \times \frac{32 \times 1{,}500}{1{,}000} \times 7 + 400 = 504{,}400 \text{ pence per annum.}$$

$$(2.)\quad 1{,}500 \times \frac{32 \times 1{,}500}{1{,}000} \times 30 \times \frac{1{,}000}{746} \times 1{\cdot}1 \times \frac{36}{1{,}000} + 14{,}400 + 13{,}260 + 28{,}000 + {\cdot}360 = 170{,}680 \text{ pence per annum.}$$

$$(3.)\quad \left(1{,}500 \times \frac{8}{2\frac{1}{2}} \times 1{,}500\right) \frac{36}{1{,}000} + 360 = 259{,}560 \text{ pence per annum.}$$

In an installation of this size we find the gas engine plant comes first in point of economy, gas burnt direct in the burners being about 1½ times as dear, and the supply company at 7d. per unit, about 3½ times as much.

In order to arrive at the total actual cost of upkeep of such an installation as this, the cost of lamp renewals and interest on wiring and fittings should be added to the yearly maintenance. The lamp renewals must be very close upon 100 per cent., having regard to the number of burning hours per annum, and the cost of wiring and fittings for such an installation can hardly have been less than £1,700 if the wiring was carried out thoroughly well, so that 5 per cent. on £1,700 + 3 per cent. on £1,700 + 1,500 × 3s. 9d., or a total of 39,390 pence should be added, making 170,680 + 110,140 = 280,820 pence per annum, which would be about equal to gas if wages of attendant and repairs and renewals of shades, &c., were taken into consideration.

Results arrived at from such calculations as these must only be taken as roughly representative, as, of course, the actual figures would in each case be greatly modified by the existence of more or less favourable or unfavourable conditions.

As regards actual figures concerning this installation, Mr. Gisbert Kapp (who designed the installation) gave some interesting details in the course of the discussion on Mr. Dowson's paper at the Institution of Civil Engineers recently, and through his courtesy I am enabled to give them here.

There are 1,500 8-C.P. or their equivalent installed, and an equivalent of 1,200 8-C.P. are in use, made up as follows:—

In the arc light circuits ...	...	4,000 watts.
In the incandescent circuits	...	34,240 „

About 72,000 units are consumed per annum, at a cost (including wages, gas, interest, depreciation, lamp renewals) of £1,196 2s. 6d. The cost for an equal amount of illumination by gas burnt in burners giving 3 candles per cubic foot of gas (a *very* liberal estimate) would be £1,307 per annum. The saving in cost of electric light over gas in actual practice is found to be:

$$\frac{1{,}307 - 1{,}196}{1{,}307} = \text{between 8 and 9 per cent.}$$

We may, however, conclude from the foregoing, that an installation of say, 1,000 8-C.P. lamps is the limit of size in which a private plant for generating electrical energy for lighting purposes is economical in a town where gas costs 3s. per thousand cubic feet, and where electrical energy supplied by a public company costs 7d. per unit.

Numerous other methods have been suggested from time to time, whereby electrical energy may be conveniently and economically generated by private plant such as primary batteries, water motors driven from the London Hydraulic Company's mains, Davey safety motors, and so forth, but in each of these cases the economy is mainly conditioned by the convenience, and convenience is always a matter of personal opinion, and is naturally a function of existing resources and opportunity. Thus what might be a convenient and economical method of supply for a country house far removed from gas or a local electric supply company, would hardly be convenient or economical for a house in Park Lane.

The cost of generation per unit by the most efficient and economical primary battery I know of is not less than 2s. at the present price of zinc, and by a Pelton waterwheel driven from the Hydraulic Company's mains, 2s. 1d. The cost by a Davey motor is difficult to estimate as, apart from fuel consumption, a considerable quantity of water is required for condensing purposes.

It may be stated generally that in a town like London the most economical way to produce an illuminating effect up to a certain point without regard to any attendant circumstances is by burning town gas in good ordinary burners, and that any efforts to produce or obtain any illuminating effect up to this limit by the generation and expenditure of electrical energy, except in the form of the arc light (which cannot be said to be comparable with existing methods of domestic lighting) must prove abortive from the point of view of money cost only.

A great deal has been said and written about the future of electricity as a source of heat in domestic economy; in fact, in a recently published handbook on the subject, it was stated that in certain flats now in process of construction, arrangements were being made to heat and cook wholly by electricity. From the point of view of money cost alone, any doubts as to the economy of such an arrangement over coal or gas can very quickly be cleared up.

To warm a room 20 feet by 16 feet from 8 a.m. to about

10 p.m. on a cold day in winter, would require about an ordinary scuttleful and a half of coal. The average weight of this amount of coal is not less than 50 lbs. Assuming that average house coal at 23s. per ton liberates 11,000 thermal units per pound burnt in an ordinary grate, we get:—

$$\frac{50 \times 11{,}000}{14} = 40{,}000 \text{ B.T.U. liberated per hour.}$$

In such a calculation as this we may neglect the heat required to warm the grate and the air and furniture in the room to the ordinary temperature during the day, and assume that this amount of heat is required to keep up the temperature of the room for each hour during the day.

It is, however, usually admitted that the ordinary grate is only about 20 per cent. efficient as far as heating the room is concerned, therefore we may say that any means of heating the room which would be 100 per cent. efficient would require to liberate 8,000 B.T.U. per hour.

Heat can only be produced electrically by interposing a resistance to the passage of the current whereby electrical energy is absorbed, or consumed (in the language of the supply companies' accounts).

Now 1 B.T.U. = 772 foot-pounds.

∴ 1 B.T.U. liberated in one second corresponds to 772 foot-pounds in one second.

Further

550 foot-pounds per second = 746 watts.

Hence

$$1 \text{ B.T.U.} = \left(\frac{772}{550} \times 746\right) \text{ watts.}$$

= 1,047 watts.

= 7d. for every hour this rate of expenditure is continued.

= 3,600 B.T.U. liberated every hour.

And

$\frac{8{,}000}{3{,}600} \times 7 = 15\frac{1}{2}$d. for the same heating effect as that produced by $\frac{50}{14}$ = roughly 4 lbs. of coal costing $\frac{4 \times 23 \times 12}{2{,}240} = \frac{1}{2}$d. nearly.

We have now enough examples based upon the fairest assumptions as regards gas consistent with fact, to show that those who attempt to prove that electric light is cheaper than gas, light for light, except under the conditions of domestic lighting on a very large scale, and where water-power, or some exceptionally favourable opportunities of obtaining motive power exist, not only attempt to prove the unprovable, but do a great deal of harm to the electric light industry, in that they tend to give some colour of truth to Mr. Edison's statement that "from all one hears about electricity from electrical engineers, one is tempted to the belief that they all had a common ancestor in Ananias."

There can be no doubt, however, that for ordinary domestic lighting, the electric light at 7d. per unit may quite reasonably be said to be cheaper than gas *if all the attendant advantages are estimated at a fair money value (where possible) and set down as credit notes against the actual amount paid to the supply company.*

(*To be concluded.*)

REVERSIBILITY OF THREE-PHASE MOTORS WITH INDUCTIVE WINDING.*

BY ERNST DANIELSON.

ONE of the most interesting electrical machines of to-day is certainly the three-phase motor with inductive winding. A feature of this motor, which I believe has not yet been pointed out, is that it can also be used as a generator exciting its own field. This experiment has just now successfully been carried out in the works of Allmaenna Svenska Elecktriska Aktiebolaget, in Westeras, Sweden (The General Swedish Electric Company).

* New York *Electrical World*.

The experiment was arranged as follows: A threephaser, A, of 50 volts (as measured from the neutral point to each of the brushes), and with a current capacity of about 60 ampères, sent current to a motor, B, with inductive winding of about the same capacity. The construction of the motor was substantially the same as that of Brown, described in the *Electrical World*, November 7th, 1891. The motor, by means of a belt, ran a continuous current dynamo, C, of 330 volts and 16 ampères. Then matters were reversed so that dynamo, C, fed from a 330-volt circuit, ran the motor, B, as a generator, sending a rotary current to the threephaser, A, which then became a motor. The belt was then thrown off of A, and trials were made to break it out of step with the current, but without success. The break used was simply a lever made of wood and acting on the pulley. With these poor facilities, of course, no real measurement of the horse-power could be made, but at all events, the torque was considerable.

The explanation of the possibility of such a motor to act as a generator is this:

From theory and experiment it is known that when two attractions (single phasers or multiphasers) are working synchronously, one as a generator and the other as a motor, the phase of the current lags behind the E.M.F. of the motor, whereas it is in advance of that of the generator. The result of this is that the current weakens the motor field and strengthens that of the generator. The action of the inductive three-phase motor, as a generator, then, is this: The armature current induces magnetic lines in the field, and these lines, by means of the closed circuit winding, are prevented from changing their position very rapidly in the iron, and, therefore, they must rotate with nearly the same speed as the rotation takes place. Now, this field is capable of maintaining the current, provided the conditions in the external circuit are such that the current comes in advance of the induced E.M.F. These conditions can be fulfilled by having a regular three-phase generator in circuit, or by condensers. It would be impossible to have the motor act as a generator on a regular lamp circuit, or a circuit with self-induction. Experiments also showed this: Resistance boxes were connected between the leads joining the threephaser and the motor. When the motor, B, ran as a generator it accordingly sent current not only to the threephaser, A, but also to the three resistance boxes. When the threephaser was switched off, the motor, B, immediately stopped generating.

Westeras, Sweden, *December*, 1892.

LEGAL.

NATIONAL TELEPHONE COMPANY *v.* GRAFF-BAKER.

High Court of Justice.—Chancery Division.

MR. JUSTICE KEKEWICH delivered judgment in this case on Saturday, February 4th, in the following terms:—

As between the National Telephone Company, whom I shall treat as the sole plaintiffs, although another is associated with them, and the Leeds Corporation, whom I shall treat as the real defendants, although not appearing upon the record, there is no question of title, and no question but that each is lawfully exercising undoubted rights. Nor is there any question but that the acts of the defendants interfere with the exercise by the plaintiffs of their lawful rights. This would, I believe, have been undoubtedly true if the case had been thrashed out on evidence without the advantage of Mr. Macrory's report; but that report renders it unnecessary to deal with the evidence on this point. And the interference is of a serious character, so that if actionable the remedy would properly be by injunction rather than by damages. The real and only question in the case is whether the interference is actionable. It was practically admitted by the plaintiffs, and my own view certainly is, that, if they can maintain the action against the defendants at all, it must be on the application of the principle now well known as that of Fletcher *v.* Rylands (L. R., 3, H. L., 330). That principle, for the purpose of application to the case in hand, may conveniently be stated by reference to the second of four propositions set out in the fifth chapter of Mr. Garrett's book on "The Law of Nuisance," which I have consulted in connection with more than one point in this case, and gladly take this opportunity of mentioning as a work of uncommon merit. The proposition is, I think, capable of improvement by the substitution for "non-natural" of "extraordinary," which is the term employed by Lord Kingsdown in defining somewhat analogous water

rights in his well-known judgment in Miner *v.* Gilmour (12, Moore's P. C. Cases, 131). The land into which the plaintiffs and defendants alike discharge their electric current does not belong to either of them; but, for the reasons above indicated, there cannot, as between them, be any question that the principle ought to be applied (if it be applicable at all) on the basis of their being absolute owners. That principle has never yet been applied in English law to such a matter as is now under consideration; and perhaps it would not be too much to say that those who enunciated the law in Fletcher *v.* Rylands, and have commented on and followed it in other cases, never had present to their minds the application of the doctrine to an electric current and the possible consequences of its discharge into the earth. The question has been carefully considered in America, and I have studied with deep interest the case of Cumberland Telephone and Telegraph Company *v.* United Electric Railway (42, Federal Reporter, 273). The judgment of the Court in that case, though in no wise binding on me, has commanded my earnest attention and respect, and but for one circumstance I should not hesitate to allow my own conclusion to be guided by the powerful arguments there set forth. That one circumstance is the want of full adoption of the principle of Fletcher *v.* Rylands. American law, apparently, holds the owner of land used for non-natural or extraordinary purpose responsible for the consequences of such user to his neighbour only when they result from that owner's negligence, and if he can satisfy the Court that he has not been guilty of negligence, the resulting damage to his neighbour is not actionable. It seems to me that, if the principle of Fletcher *v.* Rylands had been fully adopted in America, the conclusion of the Court in the case just cited must have been different. I believe that in Scotland, too, the principle of Fletcher *v.* Rylands has not been accepted, and is not regarded as consistent with justice between man and man. It does not fall to me to consider so large a proposition. The principle is thoroughly well settled here, and my duty is merely to consider whether it is applicable. It would be easy, of course, to point out differences between all the cases to which it has hitherto been applied and the present; and I have already said that injury arising from such a case as the discharge of electric current can scarcely have been contemplated by any judge in previous cases. But, after reflecting much on the novelty of the case, on the arguments addressed to me, and on the peculiarity of an electric current as distinguished from every other power, I fail to see any reason why the principle should not be applied to it. I cannot see my way to holding that a man who has created, or, if that be inaccurate, called into special existence, an electric current for his own purposes, and who discharges it into the earth beyond his control, is not as responsible for damage which that current does to his neighbour as he would have been if instead he had discharged a stream of water. The electric current may be more erratic than water, and it may be more difficult to control its direction or force; but when once it is established that the particular current is the creation of, or owes its special existence to, the defendant, and is discharged by him, I hold that, if it finds its way on to a neighbour's land, and there damages the neighbour, the latter has a cause for action. At any rate, I think that if a distinction is to be taken between this and other forces for this purpose, that distinction must be made by a higher tribunal, and not by a judge of first instance. It was endeavoured to be argued, on behalf of the defendants, that the current injuring the plaintiffs was only part of the general body of electricity which may be now said to exist everywhere, and to be proceeding in every direction; but the effect of the defendants' operations is to collect a particular portion of this body, and to discharge it into the earth at a particular spot, and there can be no doubt but that the disturbance of the plaintiffs' telephonic system is caused by the particular quantity thus discharged. Assuming the action to be maintainable, on the principle of Fletcher *v.* Rylands, the defendants rely on two answers to the plaintiffs' claim. First, they say that the plaintiffs might, by an alteration of their system—that is, by the adoption of what is known as the metallic return—prevent the disturbance complained of; and, secondly, they say that they, the defendants, are acting under statutory powers, and that if, in the proper exercise of those powers they injure the plaintiffs, they are free from blame. The first answer is, to my mind, without foundation. The man who complains of his land being thrown out of cultivation by the incursion of water escaping from his neighbour's reservoir, must not be told that he has no right of action, because, if he had interposed a wall, or otherwise taken care to protect himself, the water would not have reached his land. He is using his land in a natural way, is not bound to take extraordinary precautions, and is entitled to rely on his neighbour also using his land in a natural way, or if he uses it otherwise, taking extraordinary precautions to prevent damage to others therefrom. There is, no doubt, a body of evidence to show that a system different from that adopted by the plaintiffs has been adopted elsewhere with advantage, and may possibly prove to be the most convenient, though more expensive for them; but the evidence also proves that their present system has been largely adopted, and is received with favour by many competent to form an opinion. It also has the merits of economy. They are carrying on their own business lawfully, and in the mode which they deem best, and I cannot oblige them to change their system, because they might thereby possibly enable the defendants to conduct their business without the mischievous consequences now ensuing. True it is that the analogy introduced above fails to this extent, that the plaintiffs are using the law for an extraordinary purpose, but, admittedly, it is a lawful purpose; and though under an obligation to obviate mischief from their own operations to their neighbours, they are under none, in my judgment, to protect themselves from the defendants or others. The outflow from one reservoir might easily destroy another; but, so far as I am aware, there is no principle or authority in English law for rejecting a claim for damage by the owner of the latter, on the ground that his user, as well as that of his neighbour is extraordinary. The second answer of the defendants to the plaintiffs' claim has required more examination. Having recently had occasion, in Allison *v.* City and South London Railway Company, and again in Rapier *v.* London Tramways Company, to consider such a plea as is here put forward, and to consider many authorities, and in particular, the cases of Metropolitan Asylums District *v.* Hill (6 App. Ca., 193), and London, Brighton and South Coast Railway Company *v.* Truman (11 App. Ca., 45), and their application to different provisions and circumstances, I do not find it necessary again to state my view of the law, or of the lines by which I ought to be guided in applying it to a particular case. Therefore I shall but briefly explain the reasons for my conclusion that the defendants' plea is good in law, and that they are not responsible to the plaintiffs for the mischief caused by their works. The defendants' authority is derived under a provisional order confirmed by Act of Parliament. Such provisional orders in connection with tramways, and many other undertakings of a public character, are now common, and, I think, must be treated as "a well-known and recognised class of legislation," equally as much as the Railway Acts, which were referred to in those terms by the Lord Chancellor in London, Brighton and South Coast Railway Company *v.* Truman (11 App. Ca., 53). The Railway Acts (again using the language of the Lord Chancellor in the same case) were assumed to establish the proposition that the railway might be made and used, whether a nuisance were created or not; and, in my judgment, a like proposition must be assumed to be established by the provisional orders, one of which is here under consideration. The defendants are expressly authorised to use electrical power; and the Legislature must be taken to have contemplated it, and to have condoned by anticipation any mischief arising from the reasonable use of such power. A distinction was endeavoured to be made between cases where extraordinary powers are directly sanctioned by the legislature, and those where it is left to some other authority (in this instance the Board of Trade) to determine whether, if at all, they may be brought into operation. It is within the competence of the Legislature to delegate its authority; and when once that delegated authority has been properly exercised by the agent to whom it is entrusted, the sanction is that of the Legislature itself, just as much as if it had been expressed in the first instance in an Act of Parliament. The defendants relied on the 51st section of the provisional order. They argue that the exception there made in favour of the telegraphic, which would include telephonic, lines of the Postmaster-General indicates that interference with any other like wires was intended to be permitted. The reference supports the more general argument, and I have therefore mentioned it; but I rest my decision more on the established principle laid down in many cases, and ultimately ratified by the House of Lords in London, Brighton and South Coast Railway *v.* Truman. To that plea of statutory power the plaintiffs have a rejoinder. They say that such power cannot avail the defendants, unless they have acted reasonably in the exercise thereof, and have done their best to avoid injury to their neighbours. The argument being sound in law, one is compelled to examine the facts. The defendants work their tramways on what is called "the single trolley system." There are other systems which have from time to time been used, and, it seems, are still in use elsewhere, and there are at least some good reasons for the conclusion that, by the adoption of one or other of these systems, the defendants might wholly or partially avoid the mischief which they now occasion. There is a contest on the evidence whether any of these other systems can be regarded as good apart from comparison with that of the defendants; and there is a further conflict of evidence whether, if good, they are comparable in merit with that of the defendants. My conclusion from the evidence is that the defendants' system is, on the whole, the best which practical science has yet discovered, but there is no occasion really to go as far as this. It is enough to say—and about this I entertain no doubt—that it is at least as good as any other, and has been proved by experience, especially in the United States, where there have been larger opportunities for experiment and consideration, to be as likely as any other to meet the requirements of traffic, and the convenience of all concerned in the protection of the site of tramways for the use of legitimate purposes other than those of the tramway undertaking. It cannot be that in the application of the law which I am now considering the Court is bound to hold a railway or other company liable for the consequences of acts done under statutory powers, because it has not adopted the last inventions of ever-changing, ever-advancing scientific discovery. It is surely impossible, with any regard to that common sense which, after all, is the foundation of this and many other branches of law, to say that a railway company which was not liable last year, last month, or even yesterday, because, until then, its undertaking was carried on according to rules acknowledged to be the best, it is liable now, not because those rules have been proved to be altogether wrong in practice or unscientific in principle, but because some diligent worker in this department has discovered what is held for the moment to be a large improvement, but may to-morrow turn out to be only a step in the progress of further advance, and yet this might be the necessary conclusion in many cases, and, indeed, might be the necessary conclusion here, if I were driven to support the plaintiffs' claim on the ground that the single trolley system, so largely approved where it has been largely tried, does not avail the defendants as a proper exercise of their statutory powers because another system is in use, and apparently successful use, at Buda Pesth or elsewhere. I do not wish to prejudice the question whether a charge of negligence in the exercise of statutory powers can be supported by cogent evidence that the company exercising those powers has failed to adopt alterations or precautions, which sufficient experience has shown to be of large, indisputable, and permanent value. That question may easily arise in many of the disputes which are likely enough from time to time to occur between public companies and those whom their operations injuriously affect; and it may even arise between the parties to this litigation. Suffice it to say that it does not arise now. Holding, on the above grounds, that the plaintiffs cannot maintain an action, either for an injunction or for

damages, against the defendants, I must order them to pay the general costs. If ever there has been or can be a case to which the distinction between the two scales of costs is properly applicable, this is the one; and the costs must be taxed on the higher scale. But it remains to make an exception, and that of some extent. I have already stated that the interference with the plaintiffs by the defendants is beyond doubt. I do not think that this ought to have been litigated. Mr. Macrory's report shows that one fair experiment would have proved the facts about which there really was very little doubt, independent of his report, and that much time was uselessly spent on evidence. Not only must the plaintiffs be excused payment of the defendant's costs of this issue, which must be defined to be the issue whether the plaintiffs' telephone system was in fact interfered with by the defendant's operations, but the costs thus excepted from the general costs of the action must be borne by the defendant and set off. Those costs will, of course, include those incurred in the experiments conducted at Leeds under Mr. Macrory's superintendence. They must also include the fee payable to Mr. Macrory, which it was agreed I should settle. I have communicated with him and ascertained the time occupied, and also the expenses incurred by him in railway journeys and the like, including the expenses of the gentleman (Mr. Cuninghame) whom he asked to assist him; and taking into consideration these items, I have fixed the fee at 50 guineas to cover all expenses, and also such fee as he thinks fit to pay Mr. Cuninghame. I am glad to think that the course pursued with the concurrence of both parties of sending him down to make experiments and report was not only successful in finally settling an issue of fact, but also shortened the trial and saved the further costs which further dispute on this point would necessarily have involved. There will be judgment for the defendant with costs, modified in the manner above expressed.

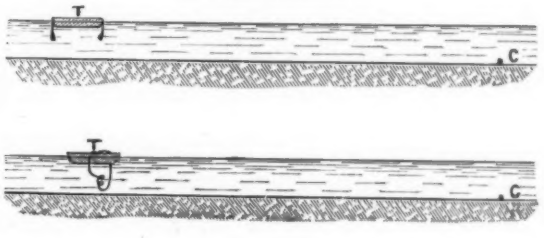
ELECTRICITY AND GAS.

COL. MAKINS, presiding at the half-yearly meeting of the Gas Light and Coke Company, on Friday last week, at the offices, Horseferry Road, in the course of his remarks in moving the adoption of the report, called special attention to the inaugural presidential address of Mr. W. H. Preece, F.R.S., at the Institution of Electrical Engineers. He said that Mr. Preece had used very strong language with regard to certain companies, and had said that there was no more monstrous waste than had been caused by the promotion of some public companies under the limited liability system. But it was all very well for certain scientific gentlemen who had given their names to prospectuses as consulting engineers, and had prepared careful estimates which had turned out to be utterly inadequate—some of those gentlemen who now found that the game was up had split upon their "pals" and left them. It should be remembered, however, that they were "in the swim," and that it was their estimate which helped the promoters to promote the companies; and it was hardly decent for them to allocate all the blame upon the promoters, and take none of it themselves. Mr. Preece was a very practical man, and he saw that the game was up, and that the British investor was not at all prepared to go in for the electric lighting companies; and that new ground must therefore be found, and he looked to others to take up the electric light. No doubt some of those present had read the interesting account of the installation of the electric light in St. Pancras, by Mr. Eccleston Gibb. He (Col. Makins) had read it, and he had come to the conclusion that he should not at all like to be a resident of St. Pancras. Although his rates were rather stiff in Westminster, he thanked heaven that he was not a ratepayer of St. Pancras, for before very long there would be a great outlay which would cause them to open their eyes very widely. Well, Mr. Preece said that the glow lamp was, and would be, "the poor man's friend." He (Col. Makins) thought the gas burner was the poor man's friend. It was useful for many purposes, for he could boil his kettle and light his pipe with it; and certainly he could not do that with the glow lamp. If the glow lamp was to become the friend of the poor man, he was sure it was not the friend of the rich man. He recollected reading an account of some members of a Pall Mall club who, during the recent cold snap, were shivering and cursing the electric light, and bemoaning the departure of gas. There were two sides to every question, and the ordinary consumer of gas did not complain, and did not want to replace gas, as Mr. Preece would lead them to suppose. Mr. Preece finished up by prophesying—and scientific men were always at their best at that—saying that if the electric light could be maintained during the whole of the 24 hours, and, of course, if there was a friendly waterfall, electrical energy could be manufactured for one-third of a penny per supply unit, and that was equivalent to a cost of 2d. per 1,000 cubic feet of gas! He supposed that they would still require a water supply. He, however, could hardly understand a man, occupying such an important position as Mr. Preece did, giving utterance to prophecies of that kind. They appeared to him but to deserve to be called "sublimated drivel." The gas companies were being continually advised that they ought to take up the electric light, and it was strongly urged upon them by strangers. But they spoke without the book, for the companies would not have been at all averse to supplying the light if their customers had desired to have the electric light as well as gas—if Parliament would have granted them the necessary powers for the purpose; but the Board of Trade had distinctly declined to allow the gas companies to take up the electric light as part of their business. They were blamed by Mr. Preece for what, after all, was no fault of their own.

INDUCTION AT GREAT DISTANCES THROUGH THE AIR AND WATER WITHOUT THE USE OF PARALLEL WIRES.

A PAPER on this subject was recently read by Mr. C. A. Stevenson, C.E., before the Royal Society of Edinburgh. At the beginning of last year he had proposed, as he explained, that a cable might be laid down in the sea, and by changing the electric state of the cable, that vessels passing near or over it might be enabled by means of a detector on board to discover that they were in its vicinity, and hence to locate their position. After satisfying himself, with some experiments, that the method was feasible, and that water offered no unsurmountable difficulty, and having been assured that no known instrument could detect the currents that could, with present machinery, be passed through a submarine cable, he had made further experiments, with the result that he had made two such instruments that would act through over 30 fathoms of water, and, without making any claim for novelty, he added that he had been unable to discover their like. He referred to previous experiments in the same direction, and then described the instruments which he had himself devised. The first of these was a coil of uninsulated copper wire rope, or other water connection, dipping into the water at the bow of a boat, and a similar water connection at the stern; if these were joined by a wire with a telephone on the circuit it would be found that a very sensitive instrument was produced, and that when the wire from bow to stern of the boat was at right angles, or nearly so, to a cable laid in the water, at some distance from it, the sounds produced by a magneto-electric machine connected to one pole of the machine were audible in the telephone. If the water connections were equi-distant from the cable, as they would be if the boat were immediately over the top of it or lying broadside on, no sound was, of course, heard. The action took place when the coils in the water were insulated. The cable also might be insulated or uninsulated. The apparatus appeared to act electrostatically, and on the principle of a voltmeter detecting differences of potential produced by the charging and discharging the cable. It was injuriously affected by the increase of conductivity of the water between the water connections due to increase of salinity, but the law by which it varies he had not determined. With the coils separated 10 feet (at the bow and stern of a small boat) and over an insulated wire laid through a small lake of brackish water, 2½ fathoms in depth, the alternations produced by the bobbins of ⅛ths of one of De Meriten's machines used at the Isle of May Lighthouse, and maintaining 80 volts at its terminals, was perfectly distinct at the end of the loch, 340 feet away from the wire, and the limit of

FIG. 1 (ELECTROSTATIC).



C, Cable; T, Telephone.

FIG. 2 (ELECTRO-MAGNETIC). ⅛

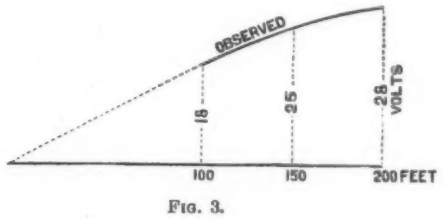


FIG. 3.

audibility could not be ascertained. The sound in the telephone was there quite distinct, and did not perceptibly fall off in the last 50 feet. The next instrument was simply a coil of insulated wire surrounding a core, *i.e.*, an electro-magnet with a telephone in the circuit of the coil. This instrument was tried at various distances, and the making and breaking of the current produced by six dry cells flowing through a wire $\frac{1}{16}$th inch diameter, and 200 feet in length, could be detected 40 feet off; and the current from 12 dry cells could be detected through 60 feet salt water. When sunk in water the sound seemed just as loud, and there seemed to be no practical difference to the efficiency of the instrument caused by the water, salt or fresh. The action of the instrument appeared to be that the break, which was well known as a much more marked phenomenon than the "make," if broken sufficiently rapidly produced an induced current in the coil, which the core confirmed, and the effect on the instruments was apparently simply affected by the number of ampères. He soon found that the distance at which the instrument was audible

in air was roughly, for small currents, at any rate, proportional to the current in ampères, and this was also the case in water for currents not differing widely in strength. The sound in a Bell telephone with this instrument was almost deafening with 3½ fathoms. The result did not appear so effective with a closed circuit of a small magneto machine as with the current produced by dry cells being made and broken. This electro-magnetic system, in contradistinction to the parallel wire systems, had no earth connection, being entirely insulated, and must therefore be a case of true induction through air or water.

NEW PATENTS—1893.

1,407. "Improvements in or relating to the production of aluminium." C. ALLEN, J. CLARK, and G. W CLARK. Dated January 23rd.

1,416. "A new or improved electric alarum for use in hotels or other large buildings, or otherwise." L. G. WEYGANG. Dated January 23rd.

1,435. "An improved supporter for the receivers of telephones and the like." A. CONNELL. Dated January 23rd.

1,444. "Improvements in electric storage battery plates." E. BAILEY and J. D. MASSEY. Dated January 23rd.

1,449. "Electrical hose signalling apparatus." W. FOWLER. Dated January 23rd. (*Complete.*)

1,502. "Improved process and apparatus for the electrolytic production of porous finely subdivided lead for use in secondary batteries." W. P. THOMPSON. (Communicated by E. Correns, Germany). Dated January 24th. (*Complete.*)

1,528. "Improvements in the electrical insulation of wires." W. MOSELEY and E. OLDENBOURG. Dated January 24th.

1,539. "Improvements in and connected with arc lamps." C. A. PFLUGER. Dated January 24th.

1,561. "Improvements in dynamo-electric machines or electric motors." H. H. LAKE. (Communicated by R. Lundell and E. H. Johnson, United States.) Dated January 24th. (*Complete.*)

1,574. "Improvements in current adapters for incandescent electric light circuits." J. C. FELL. (Communicated by A. F. Vetter, United States.) Dated January 24th.

1,579. "Improvements in connection with electric bells." L. G. WEYGANG. Dated January 24th.

1,592. "Improvements in the method of and means for the production electrically of spectacular effects." A. L. FYFE. Dated January 24th.

1,595. "Improvements in carriage attachments or dial indicators and electric light fittings." P. JENSEN. (Communicated by A. M. Blake, United States.) Dated January 24th.

1,610. "Improvements in electric heating apparatus." Sir D. L. SALOMONS. Dated January 25th.

1,615. "Improvements in electrical accumulators." N. S. HILL. (Communicated by I. Nicolariff, Russia.) Dated January 25th.

1,620. "Regulable electric lamp." G. HALL and J. DE MARR. Dated January 25th. (*Complete.*)

1,621. "An improved system of distribution for polyphase alternating currents." C. S. BRADLEY. Dated January 25th. [Date applied for under Patents Act, 1883, Section 103, July 29th, 1892, being date of application in United States.] (*Complete.*)

1,661. "Improvements in electrolytic apparatus." E. ANDREOLI. Dated January 25th. (*Complete.*)

1,675. "Process for treating the effluent from electrolytically or chemically purified sewage for neutralising its alkalinity, and for the production of bye-products therefrom." W. WEBSTER. Dated January 25th.

1,683. "Improvements in electric arc lamps." F. G. LOTT. Dated January 25th.

1,697. "An improved electric clock." G. BINSWANGER and H. J. COATES. Dated January 25th.

1,720. "An improved electric alarm." M. C. GREENHILL. Dated January 26th.

1,759. "Improvements in electrical apparatus for use in ship's telegraphs and other purposes." G. F. FLEMMICH. Dated January 26th. (*Complete.*)

1,778. "Improvements relating to the coating of articles with alloys by electro-deposition." THE LONDON METALLURGICAL COMPANY, LIMITED, and S. O. COWPER-COLES. Dated January 26th.

1,789. "Improved means for supporting telegraph and the like wires upon draw-bridges." J. B. SEAGE. Dated January 26th.

1,812. "Electric light regulating switches." R. J. SANSOME and H. HAWES. Dated January 27th.

1,829. "An improvement in electrical transmitters." W. A. M. BROWN. Dated January 27th.

1,840. "Improvements in and connected with electric signalling on railways." T. E. DEAN. Dated January 27th.

1,849. "A new and improved form of two-way electric switch." A. S. GILES. Dated January 27th.

1,863. "Improvements in the manufacture of insulators such as are used in electric lighting." H. L. DOULTON. Dated January 27th.

1,894. "Improvements in self-regulating dynamo-electric generators and motors." I. A. TIMMIS and A. I. SMITH. Dated January 28th.

1,895. "An improved and simple means of procuring a 'dead-beat action' of a coil or coils of wire, suspended and moving horizontally or vertically in a magnetic or electro-magnetic field of force." T. CLARK and W. B. REDGRAVE. Dated January 28th.

1,902. "Improvements in or relating to metallic junction boxes for concentric electric conductors, and in the mode of connecting conductors therein." H. A. MAVOR, W. A. COULSON, S. MAVOR, and W. B. SAYERS. Dated January 28th.

1,948. "An improvement in secondary voltaic batteries." H. IMRAY. (Communicated by La Société Anonyme pour le travail electrique des metaux, France.) Dated January 28th.

1,951. "An improvement or improvements in the arms used for supporting insulators on telegraph poles." T. G. MARSH. Dated January 28th.

1,956. "Improvements in dynamo-electric machines." S. P. THOMPSON and W. M. MORDEY. Dated January 28th.

1,958. "Improvements in electric telegraphs and mechanism in connection therewith." Sir J. ANDERSON and A. FRASER. Dated January 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,798. "Improvements in electrical signalling apparatus" F. HANUSSE and G. BORREL. Dated May 23rd. Signals are produced by changing the position of plates which so long as they remain vertical form a screen, but when they are turned to the horizontal position the apparatus conveys to the observer the appearance of an empty space surrounded by the frame. These two positions of the plates thus constitute two different signals, either of which may be given in $\frac{1}{10}$th of a second. 1 claim.

9,637. "An improved automatic electric control or cut-out." H. ALABASTER and T. E. GATEHOUSE. Dated June 6th. Consists in the use of the well-known thermostatic arrangement of two metals having unequal coefficients of expansion, and this is made part of t e electric circuit, the sectional area of the thermostat being proportioned to that of the copper conductors. One end of the thermostat, which may be flat or coiled, is fixed to one end of the conductor, and the other is free to dip into and rise out of a metal cup, say of iron containing mercury, from which the other end of the conductor is led away. The current passes through the thermostat forming a part of the circuit, and on any excess above the normal the slightly extra heating immediately takes effect on the thermostatic bar, and the contact between the end of the thermostat and the mercury is broken under water or oil if desirable. Upon cooling sufficiently the circuit is re-established. To prevent, however, a complete severance of the circuit, the inventors insert between that end of the thermostat which dips into the mercury and the end of the conductor which is led away from the mercury cup, a resistance equivalent to that of the lamp circuit or of any desired proportion; the current then flows, when the thermostat is withdrawn from the mercury, through this resistance, which reduces the current and therefore the heating effect again to the normal state. 3 claims.

10,434. "Improvements in electric meters." P. E. SINGER. Dated June 19th. The inventor connects two bulbs or vessels of equal volume and preferably identical shape by a tube containing mercury. Through either of these bulbs a coil of naked wire passes. The current flowing through this wire, which is insulated from the walls of the bulb, heats it, and the enclosed air causing the latter to drive the mercury into the other bulb. When the mercury attains a particular level in the bulbs, the fact of a certain quantity of electricity having passed is declared, and the mercury on attaining this level is made to close a derived (or an independent) circuit which excites an electro-magnet, and this in turn operates a "step instrument," consisting of a rack or pall in connection with a train of clock wheels by means of which the fact of a definite quantity of electricity (which shall henceforward be called the unit), having passed is permanently recorded. The action of the electro-magnet on the "step instrument" also breaks the circuit containing the coiled naked wire in the bulb and switches on the current to be measured, to a similar naked coiled wire in a perfectly similar bulb, when a similar action goes on, and a record of another "unit" having passed is made by the clock train. 3 claims.

10,613. "Glow lamps for rotary-phase currents." SIEMENS BROS. and Co., LTD. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated June 22nd. Claim:—Constructing glow lamps for rotary-phase current installations with three or more electrodes, corresponding in number to the number of alternating currents employed, and with a corresponding number of leads, these being all connected together within the lamp by means of a suitable arrangement of incandescence bodies in such manner that the uniformity of the loads of the several conductors is insured while maintaining the independence of all the lamps, substantially as described.